U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-274 877

Effluent Monitoring Procedures
Basic Parameters for Municipal Effluents

Nat'l. Training & Operational Technology Center, Cincinnati, OH

Nov 77

PB 274 877

[illegible] GUIDE

ENVIRONMENTAL PROTECTION AGENCY

[illegible]

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

BIBLIOGRAPHIC DATA SHEET

1. Report No. EPA-430/1-77-008

2.

4. Title and Subtitle

Effluent Monitoring Procedures: Basic Parameters for Municipal Effluents - Staff Guide

5. Report Date November 1977

6.

7. Author(s)

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8. Performing Organization Rept. No.

9. Performing Organization Name and Address

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Municipal Operations & Training Division
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Cincinnati, Ohio 45268

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

Same as #9 above.

13. Type of Report & Period Covered

14. 728/82

15. Supplementary Notes

Supercedes EPA-430/1-74-011

16. Abstracts

This manual is designed for use by instructors who will have to teach others how to perform National Pollutant Discharge Elimination System (NPDES) analyses. It is to be used in conjunction with the student reference manual bearing the same title (EPA-430/1-77-003). It includes topics related to the presentation of training courses in which the analyses would be taught. These topics include: examples of course announcements, course agenda, and course certificates; consideration of training staff, training facilities, course records, and registration procedures. Also included are Instructional Package Worksheets (lesson plans) giving details relative to presenting instruction regarding each of the analyses covered in the associated student reference manual.

17. Key Words and Document Analysis. 17a. Descriptors

Training, Education, Schools, Environment, Analysis, Analytical, Analytical Techniques

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 14-B, 07-B, 12-A

18. Availability Statement

Release to the public

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page) UNCLASSIFIED

21. No. of Pages 272

22. Price PC A12-A01

FORM NTIS-35 (REV. 3-72)

USCOMM-DC 14952-P72

STAFF GUIDE
for
CONDUCTING THE COURSE

SELF-MONITORING PROCEDURES: BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS

U. S. ENVIRONMENTAL PROTECTION AGENCY
Water Program Operations
Municipal Permits and Operations Division
National Training and Operational Technology Center

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PREFACE

TO THE USER OF THIS MANUAL

Background of Effluent Self-Monitoring Requirement

With passage of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) a new permit program was created to replace and improve upon the earlier permit system which existed under the 1899 Refuse Act.

Under the 1972 Act, the United States Environmental Protection Agency is required to establish national effluent limitations and national treatment performance standards for all sources of water pollution, including not only municipal discharges, but also factories, animal feedlots, and power plants. These effluent limitations are the maximum amount of a pollutant that any discharger may release into a water body.

In order to insure that the prescribed effluent limits are met, every discharger is required to obtain an NPDES (National Pollutant Discharge Elimination System) Permit. Types of water discharge sources for which a permit is required include municipal wastewater treatment facilities; manufacturing plants; agriculture, forestry, mining and fishing operations, and other service, wholesale, retail, and commercial establishments having operations which result in discharge of water to the Nation's bodies of water.

The NPDES Permit is not a license to pollute. To the contrary, a Permit stipulates what may be discharged, and how much may be discharged over a defined period of time. Each Permit is tailored to the discharger, and sets specific limits on each effluent.

Furthermore, the NPDES Permit also requires dischargers to monitor their effluents, performing specified tests and measurements at designated frequencies specified in the individual Permit, and to report the amount and nature of all waste components discharged.

Training Need Associated with Self-Monitoring Requirements

Compliance with NPDES requires that all specified tests and measurements be performed in accordance with methods specified by EPA and announced in the Federal Register. Only under very limited conditions are deviations from specified methods acceptable.

These requirements are the basis of an immediate, massive, training need to provide the responsible waste water treatment personnel with the knowledge and skills required to comply with the self-monitoring requirement. There is at present a wide range of initial capabilities for performing the tests and measurements. This ranges from the situation in the large, fully-staffed, fully-equipped facility in which little or no training is required, through all shades and levels to the limited staff in small, inadequately-equipped facilities in which at present there is little or no capability for performing the required tests and measurements.

This is one of several special short-term courses recently developed and currently under development by the Environmental Protection Agency and associated educational institutions. This Instructor's Guide is intended to assist other training organizations in conducting training of waste water treatment plant operational personnel in the tests, measurements, and report preparation required for compliance with their NPDES Permits.

TRAINING AVAILABLE OR UNDER DEVELOPMENT TO MEET SELF-MONITORING REQUIREMENTS

Title	Workers should take this who:
Basic Laboratory Skills for Self-Monitoring Tests and Measurements	Have little or no laboratory experience or training, and need to develop basic skills including use of balances; preparation of solutions and reagents; names, characteristics, preparation and care of common laboratory equipment supplies. This course prepares students requiring such training for entry into the following named courses in which procedures for designated tests and measurements are learned.
Self-Monitoring Procedures: Basic Parameters for Municipal Effluents	Have basic laboratory skills, as designated above, but need to learn one or more of the procedures required for most or all municipal effluents including BOD, fecal coliform, pH, suspended solids, flow, and reporting of results.
Effluent Monitoring Procedures: Metals Analyses	Usually have completed the "Basic Parameters" course, but have a Permit which requires report on one or more metals.
Effluent Monitoring Procedures: Nutrients	Usually have completed the "Basic Parameters" course, but have a Permit which requires periodic report on one or more of the so-called "nutrients" including nitrogen and phosphorus.
Effluent Monitoring Procedures: Flow Measurement and Sampling Techniques	Have made arrangements whereby the required laboratory procedures are performed elsewhere by contract or other special arrangement, and who are required only to collect and care for samples, and to make such tests and measurements as must be made at the sampling site.
Any of the analytical courses of EPA National Training and Operational Technology Center for specific Permits	Are professional chemists, microbiologists, or key laboratory technicians in large treatment facilities where they work full-time doing a designated series of analytical tests and measurements.

A Personal Note to the User of this Guide

The need for providing this training, and the nature of current efforts of the Environmental Protection Agency to meet this need have been discussed in foregoing paragraphs.

It is an oversimplification of a classic quotation to say that all that is needed to conduct training is to "put Mark Hopkins on one end of a log and a student on the other." It is almost as much an oversimplification to say that all that is needed to conduct a course is to bring together the students and the instructional staff in a classroom and laboratory equipped with requisite equipment and supplies for the instruction to be delivered.

A short course such as this, involving both classroom instruction and laboratory application, and with critical learning outcomes to be achieved within a limited period of time, absolutely requires careful, detailed planning, preparation, and implementation. Meticulous attention to detail and effective staff teamwork are essential at every step of course planning, development, and implementation.

The purpose of this Staff Guide is to provide you, the training staff member, with useful, practical assistance in presenting this course in your own facilities. The Guide is a resource. It is not a blueprint to be followed rigidly or unthinkingly. Even with this guide or any other form of assistance, you will have to plan, to think and to prepare in order to perform effectively in conducting this course. On the other hand, this Guide should be helpful in reducing the amount of original development work you will have to do, and it should be helpful in suggesting factors in course planning and presentation which otherwise might be ignored or glossed over.

You are invited, in fact requested, to participate actively in making this Guide a living document which effectively represents the best experience of all in planning, preparing for, conducting and terminating this course. Please provide this office with your constructive suggestions for strengthening and improving upon this Guide, based on your own experiences in conducting the course. Your recommendations will be fully considered in future editions of this and other Staff Guides for other courses of this series. In the event that questions arise in interpretation of any aspect of this Instructors' Guide, please write or call:

Director, National Training and Operational Technology Center
Office of Water Program Operations
U.S. Environmental Protection Agency
Cincinnati, OH 45268

Telephone: (513) 684-7501

Format of this Manual

This manual consists of two major parts. Part I is concerned with administrative aspects of planning, preparing, and conducting the course. Part II consists of guidance to the instructional staff on the technical content, learning objectives to be achieved by the students, and lesson-by-lesson instructional guides for each of the several self-monitoring procedures covered in this course.

Part I, which immediately follows, will have greatest value to those conducting this course for the first time or for the first few times. With practice in conducting the training most organizations will develop their own adaptations and ramifications of this plan to meet their own requirements and the specific situation.

It is strongly urged that each institution conducting this training course develop its own formal version of such a guide as this. Staff does change; new personnel require indoctrination and training on standard procedures of the organization they have joined. Rules and procedures promulgated by regulatory authority do change; such changes will require adjustment in course content. With repetition of specified tasks, many staff members, however dedicated, do slip into unconscious variations in practice or omissions in details which can subtly change the character of the course. A formal plan and guide, consciously studied and followed, can help the training instructor and the administrator to avoid many pitfalls.

Intelligent use of a plan such as this, with variations as proven necessary, can go far in keeping this course in harmony with the needs of the students and with requirements of regulatory authorities. Above all, the course should remain free of the distractions and last-minute corrections of errors or omissions discovered at untimely stages in course preparation and presentation.

PART I - COURSE PLANNING AND MANAGEMENT

A. Course Plan and Working Schedules

This section considers five topics:

Responsibilities in self-monitoring training

It is an inherent responsibility of any teacher to provide a learning situation which gives the student the best possible opportunity to develop the target level of knowledge and skills.

In addition, and not to be overlooked, this course involves a responsibility to the regulatory agency--to assure that students acquire specified knowledge and skills and that these skills are acquired to a level such that data reported by the student will be accepted as reliable by the regulatory authority.

Announcing the course

This section gives examples of course announcements, and identifies specific information which should be provided in any course announcement.

Summary plan for the course

This is a one-page summary of the course plan in which the reader can discover the subject matter coverage, days and approximate time allocations and the designation of the instructional specialty involved in presenting the instruction.

Sample course schedule

This covers the same information as the summary plan. The format is different, providing a day-by-day, hour-by-hour class schedule. This schedule-format has been found most practical at EPA training centers for more than 20 years. It works. It is recommended for your use.

Milestones in course planning and preparation

Each member of the training staff has individual and cooperative duties in planning and conducting the course. Much of the responsibility of each staff member is outlined later in this Guide in the section on Training Staff (Outline 6). The milestone chart shown here is an example of a plan to accomplish necessary tasks in a timely manner. It is necessary that each training institution develop its own logistics of course preparation to meet the situation at hand. It is urged that a formal milestone chart be developed.

1. Responsibilities in Self-Monitoring Training

a. Implications of NPDES

Each Permit issued under the National Pollutant Discharge Elimination System (NPDES) includes a program of required self-monitoring analyses of effluents and reporting of results at prescribed intervals.

1) The methodology to be followed in performing the self-monitoring tests and measurements is described in issuances in the Federal Register (FR).

2) In some cases, two or more alternative procedures are available to the analyst for compliance with monitoring requirements.

3) Provisions do exist whereby the regulatory agencies (State and EPA) can recommend and permit use of methods not listed in the FR. Procedures for orderly application of accepted methods are described in the FR issuance at the end of this section. It cannot be too strongly emphasized that the Permit-holder does not have the authority to make a unilateral decision to introduce analytical procedures not found in the FR issuances or not specifically authorized by the appropriate regulatory authorities.

b. Training Response to NPDES/FR Requirements

1) Methods taught in this and associated courses developed by EPA are limited to those most recently prescribed in issuances of the FR.

2) Usually, when alternative methods are available, the course will include only one of the alternatives. In planning the details of a specific course offering, a training representative should in every case consult with responsible representatives of the regulatory agency in the area in which the course is conducted. This consultation should include determination of:

a) Which, if any, of more than one alternative analytical method is preferred (or required) by the regulatory agency for the Permit-holders under its jurisdiction?

b) What, if any, changes have occurred since the last course offerings which require adjustment in course content?

c) What advice does the regulatory agency have to offer about the planned course presentation based on problems encountered in implementation of self-monitoring procedures, and in observations of performance of past graduates from previous offerings of the course?

3) The training institution which fails to apply these elementary practices, with a result of sometimes teaching inappropriate methods, stands in danger of committing a serious disservice to those it purports to serve:

a) To the students enrolled in the course; and

b) To the Permit-holding organization, which is being led to believe that through this training the qualifying student will perform self monitoring tests and measurements in accordance with methods approved by the regulatory authority.

c. Responsibilities in Accreditation of Students

1) Successful completion of this course of training will be a factor used by many regulatory agencies in the accreditation or certification of treatment plant personnel to perform self-monitoring tests and measurements.

2) The instructional staff has a responsibility to provide a learning experience through which the qualifying student will have every expectation of being able to perform the required self-monitoring procedures in a satisfactory manner on return to his normal working environment.

3) Student Evaluation and Testing

For permanent record of qualification and performance, a record of student performance should be made.

a) Tests (both written and applied) should be criterion tests, i.e., designed to demonstrate ability of the student to perform the required analyses, as contrasted with tests designed to develop a comparative rating of the individual students.

b) Written tests should be strictly applied to the procedures being taught and should be appropriate to a written answer. Thus definitions, matters of specific information, solving of problems, and similar matters are appropriate to written tests.

c) Many students will take alarm at written tests, and may not perform up to expectations due to this alarm. One means of alleviating this fear is to give open-book quizzes but to expect a high standard of performance. It is pointed out here that it is more important for the student to know where to refer for needed facts and to check these facts, than it is to demonstrate rote memory. The memory will come with practice of the test procedures. The student should learn to check the facts when in doubt, rather than to risk a blunder.

d) Much of the student evaluation will be based on performance in the laboratory. It will be appropriate to keep records on such factors in student performance as:

(1) Accuracy in following directions as given;

(2) Demonstration of acceptable manipulative skills;

(3) Reporting of laboratory results falling within acceptable relationship to a class norm; and other factors as determined by the instructor.

e) Each instructor is responsible for reporting the quality of performance of each student for the procedures for which he has primary responsibility. These reports should be written, and they should be made a part of the permanent course record. This course plan provides for having at least two instructors in the laboratory during all laboratory phases of the course. At any given session, one instructor will be the designated primary instructor, with others in a supporting role. To make a system like this work satisfactorily in evaluation of students and to assure consistence in student instruction each member of the instructional team has defninte, if implied, responsibilities. These include:

(1) The primary instructor is the individual who reports on acceptability or non-acceptability of student performance.

(2) The instructor-assistant(s) must instruct students in the same way as designated by the primary instructor. Introduction of individuality in manipulative procedures, order of proceeding with a test, etc., can only confuse the student.

(3) The instructor-assistant(s) should bring the problem-student to the attention of the primary instructor at the earliest possible moment. This is to provide maximum opportunity to correct problems which might result in failure of the student to qualify in a given analytical procedure.

(4) Primary instructor and instructor-assistants have, of course, a continuing responsibility of preserving the highest standards of professional and ethical relationships with each other throughout the course. Differences of opinion will arise among individuals of any instructional staff. These differences must be resolved outside the classroom and laboratory. Furthermore, these differences are not subjects for airing with students at any time.

4) The Nonqualifying Student

a) There is a job/financial implication to any student failing to qualify for any of the analytical tests and measurements included in this course. Therefore instructors should be particularly careful to document the reasons for any nonqualification.

b) Any nonqualifying student should be entitled to be informed on the reasons why he is judged nonqualifying.

c) Ideally, an opportunity should be provided for nonqualifying students to have another chance to correct deficiencies in their performance. This could be accomplished through a number of different approaches such as makeup work (evenings) during the course itself, through repeating the training module in whicn acceptable results were not achieved (at a mutually agreeable time for the student and for the instructor), or by enrollment in a future offering of the course with participation only in the module which was failed the first time around.

federal register

WEDNESDAY, DECEMBER 1, 1976

PART II:

ENVIRONMENTAL PROTECTION AGENCY

■

WATER PROGRAMS

Guidelines Establishing Test Procedures for the Analysis of Pollutants

Amendments

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

SUBCHAPTER D—WATER PROGRAMS

[FRL 630-4]

PART 136—GUIDELINES ESTABLISHING TEST PROCEDURES FOR THE ANALYSIS OF POLLUTANTS

Amendment of Regulations

On June 9, 1975, proposed amendments to the Guidelines Establishing Test Procedures for the Analysis of Pollutants (40 CFR 136) were published in the FEDERAL REGISTER (40 FR 24535) as required by section 304(g) of the Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 816, et seq., Pub. L. 92-500, 1972) hereinafter referred to as the Act.

Section 304(g) of the Act requires that the Administrator shall promulgate guidelines establishing test procedures for the analysis of pollutants that shall include factors which must be provided in: (1) any certification pursuant to section 401 of the Act, or (2) any permit application pursuant to section 402 of the Act. Such test procedures are to be used by permit applicants to demonstrate that effluent discharges meet applicable pollutant discharge limitations and by the States and other enforcement activities in routine or random monitoring of effluents to verify compliance with pollution control measures.

Interested persons were requested to submit written comments, suggestions, or objections to the proposed amendments by September 7, 1975. One hundred and thirty-five letters were received from commenters. The following categories of organizations were represented by the commenters: Federal agencies accounted for twenty-four responses; State agencies accounted for twenty-six responses; local agencies accounted for seventeen responses; regulated major dischargers accounted for forty-seven responses; trade and professional organizations accounted for eight responses; analytical instrument manufacturers and vendors accounted for seven responses; and analytical service laboratories accounted for six responses.

All comments were carefully evaluated by a technical review committee. Based upon the review of comments, the following principal changes to the proposed amendments were made:

(A) *Definitions*. Section 136.2 has been amended to update references: Twenty commenters, representing the entire spectrum of responding groups pointed out that the references cited in §§ 136.2(f), 136.2(g), and 136.2(h) were out-of-date; §§ 136.2(f), 136.2(g), and 136.2(h), respectively, have been amended to show the following editions of the standard references: "14th Edition of Standard Methods for the Examination of Water and Waste Water;" "1974 EPA Manual of Methods for the Analysis of Water and Waste;" and "Part 31, 1975 Annual Book of ASTM Standards."

(B) *Identification of Test Procedures*. Both the content and format of § 136.3, "Table I, List of Approved Test Procedures" have been revised in response to twenty-one comments received from State and local governments, major regulated dischargers, professional and trade associations, and analytical laboratories.

Table I has been revised by:

(1) The addition of a fourth column of references which includes procedures of the United States Geological Survey which are equivalent to previously approved methods.

(2) The addition of a fifth column of miscellaneous references to procedures which are equivalent to previously approved methods.

(3) Listing generically related parameters alphabetically within four subcategories: bacteria, metals, radiological and residue, and by listing these subcategory headings in alphabetic sequence relative to the remaining parameters.

(4) Deleting the parameter "Algicides" and by entering the single relevant algicide, "Pentachlorophenol" by its chemical name.

(C) *Clarification of Test Parameters*. The conditions for analysis of several parameters have been more specifically defined as a result of comments received by the Agency:

(1) In response to five commenters representing State or local governments, major dischargers, or analytical instrument manufacturers, the end-point for the alkalinity determination is specifically designated as pH 4.5.

(2) Manual digestion and distillation are still required as necessary preliminary steps for the Kjeldahl nitrogen procedure. Analysis after such distillation may be by Nessler color comparison, titration, electrode, or automated phenolate procedures.

(3) In response to eight commenters representative of Federal and State governments, major dischargers, and analytical instrument manufacturers, manual distillation at pH 9.5 is now specified for ammonia measurement.

(D) *New Parameters and Analytical Procedures*. Forty-four new parameters have been added to Table I. In addition to the designation of analytical procedures for these new parameters, the following modifications have been made in analytical procedures designated in response to comments.

(1) The ortho-tolidine procedure was not approved for the measurement of residual chlorine because of its poor accuracy and precision. Its approval had been requested by seven commenters representing major dischargers, State, or local governments, and analytical instrument manufacturers. Instead, the *N,N*-diethyl-p-phenylenediamine (DPD) method is approved as an interim procedure pending more intensive laboratory testing. It has many of the advantages of the ortho-tolidine procedure such as low cost, ease of operation, and also is of acceptable precision and accuracy.

(2) The Environmental Protection Agency concurred with the American Dye Manufacturers' request to approve its procedure for measurement of color, and copies of the procedure are now available at the Environmental Monitoring and Support Laboratory, Cincinnati (EMSL–CI)

(3) In response to three requests from Federal, State governments, and dischargers, "hardness," may be measured as the sum of calcium and magnesium analyzed by atomic absorption and expressed as their carbonates.

(4) The proposal to limit measurement of fecal coliform bacteria in the presence of chlorine to only the "Most Probable Number" (MPN) procedure has been withdrawn in response to requests from forty-five commenters including State pollution control agencies, permit holders, analysts, treatment plant operators, and a manufacturer of analytical supplies. The membrane filter (MF) procedure will continue to be an approved technique for the routine measurement of fecal colifiorm in the presence of chlorine. However, the MPN procedure must be used to resolve controversial situations. The technique selected by the analyst must be reported with the data.

(5) A total of fifteen objections, representing the entire spectrum of commenters, addressed the drying temperatures used for measurement of residues. The use of different temperatures in drying of total residue, dissolved residue and suspended residue was cited as not allowing direct intercomparability between these measurements. Because the intent of designating the three separate residue parameters is to measure separate waste characteristics (low drying temperatures to measure volatile substances, high drying temperatures to measure anhydrous inorganic substances), the difference in drying temperatures for these residue parameters must be preserved.

(E) *Deletion of Measurement Techniques*. Some measurement techniques that had been proposed have been deleted in response to objections raised during the public comment period.

(1) The proposed infrared spectrophotometric analysis for oil and grease has been withdrawn. Eleven commenters representing Federal or State agencies and major dischargers claimed that this parameter is defined by the measurement procedure. Any alteration in the procedure would change the definition of the parameter. The Environmental Protection Agency agreed.

(2) The proposed separate parameter for sulfide at concentrations below 1 mg/l, has been withdrawn. Methylene blue spectrophotometry is now included in Table I as an approved procedure for sulfide analysis. The titrimetric iodine procedure for sulfide analysis may only be used for analysis of sulfide at concentrations in excess of one milligram per liter.

(F) *Sample Preservation and Holding Times*. Criteria for sample preservation and sample holding times were requested by several commenters. The reference for sample preservation and holding time criteria applicable to the Table I parameters is given in footnote (1) of Table I.

(G) *Alternate Test Procedures*. Comments pertaining to § 136.4, Application for Alternate Test Procedures, included objections to various obstacles within these procedures for expeditious approval of alternate test procedures. Four analytical instrument manufacturers commented that by limiting of application for review and/or approval of alternate test procedures to NPDES permit holders, § 136.4 became an impediment to the commercial development of new or improved measurement devices based on new measurement principles. Applications for such review and/or approval will now be accepted from any person. The intent of the alternate test procedure is to allow the use of measurement systems which are known to be equivalent to the approved test procedures in waste water discharges.

Applications for approval of alternate test procedures applicable to specific discharges will continue to be made only by NPDES permit holders, and approval of such applications will be made on a case-by-case basis by the Regional Administrator in whose Region the discharge is made.

Applications for approval of alternate test procedures which are intended for nationwide use can now be submitted by any person directly to the Director of the Environmental Monitoring and Support Laboratory in Cincinnati. Such applications should include a complete methods write-up, any literature references, comparability data between the proposed alternate test procedure and those already approved by the Administrator. The application should include precision and accuracy data of the proposed alternate test procedure and data confirming the general applicability of the test procedure to the industrial categories of waste water for which it is intended. The Director of the Environmental Monitoring and Support Laboratory, after review of submitted information, will recommend approval or rejection of the application to the Administrator, or he will return the application to the applicant for more information. Approval or rejection of applications for test procedures intended for nationwide use will be made by the Administrator, after considering the recommendation made by the Director of the Environmental Monitoring and Support Laboratory, Cincinnati. Since the Agency considers these procedures for approval of alternate test procedures for nationwide use to be interim procedures, we will welcome suggestions for criteria for approval of alternate test procedures for nationwide use. Interested persons should submit their written comments in triplicate on or before June 1, 1977 to: Dr. Robert B. Medz, Environmental Protection Technologist, Monitoring Quality Assurance Standardization, Office of Monitoring and Technical Support (RD-680), Environmental Protection Agency, Washington, D.C. 20460.

(H) *Freedom of Information.* A copy of all public comments, an analysis by parameter of those comments, and documents providing further information on the rationale for the changes made in the final regulation are available for inspection and copying at the Environmental Protection Agency Public Information Reference Unit, Room 2922, Waterside Mall, 401 M Street, SW., Washington, D.C. 20460, during normal business hours. The EPA information regulation 40 CFR 2 provides that a reasonable fee may be charged for copying such documents.

Effective date: These amendments become effective on April 1, 1977.

Dated: November 19, 1976.

JOHN QUARLES,
Acting Administrator,
Environmental Protection Agency.

Chapter I, Subchapter D, of Title 40, Code of Federal Regulations is amended as follows:

1. In § 136.2, paragraphs (f), (g), and (h) are amended to read as follows:

§ 136.2 Definitions.

* * * * *

(f) "Standard Methods" means *Standard Methods for the Examination of Water and Waste Water*, 14th Edition, 1976. This publication is available from the American Public Health Association, 1015 18th Street, N.W., Washington, D.C. 20036.

(g) "ASTM" means *Annual Book of Standards, Part 31, Water, 1975.* This publication is available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(h) "EPA Methods" means *Methods for Chemical Analysis of Water and Waste, 1974.* Methods Development and Quality Assurance Research Laboratory, National Environmental Research Center, Cincinnati, Ohio 45268; U.S. Environmental Protection Agency, Office of Technology Transfer, Industrial Environmental Research Laboratory, Cincinnati, Ohio 45268. This publication is available from the Office of Technology Transfer.

2. In § 136.3, the second sentence of paragraph (b) is amended, and a new paragraph (c) is added to read as follows:

§ 136.3 Identification of test procedures.

* * * * *

(b) * * * Under such circumstances, additional test procedures for analysis of pollutants may be specified by the Regional Administrator or the Director upon the recommendation of the Director of the Environmental Monitoring and Support Laboratory, Cincinnati.

(c) Under certain circumstances, the Administrator may approve, upon recommendation by the Director, Environmental Monitoring and Support Laboratory, Cincinnati, additional alternate test procedures for nationwide use.

3. Table I of § 136.3 is revised by listing the parameters alphabetically; by adding 44 new parameters; by adding a fourth column under references listing equivalent United States Geological Survey methods; by adding a fifth column under references listing miscellaneous equivalent methods; by deleting footnotes 1 through 7 and adding 24 new footnotes, to read as follows:

* * * * *

TABLE I.—*List of approved test procedures*[1]

Parameter and units	Method	References (page nos.) 1974 EPA methods	14th ed. standard methods	Pt. 31 1975 ASTM	USGS methods[2]	Other approved methods
1. Acidity, as CaCO^3, milligrams per liter.	Electrometric end point (pH of 8.2) or phenolphthalein end point.	1	273(4d)	116	40	[8](607)
2. Alkalinity, as CaCO^3, milligrams per liter.	Electrometric titration (only to pH 4.5) manual or automated, or equivalent automated methods.	3 5	278	111	41	[8](607)
3. Ammonia (as N), milligrams per liter.	Manual distillation[9] (at pH 9.5) followed by nesslerization, titration, electrode. Automated phenolate.	159 165 168	410 412 616	237	116	[8](614)
BACTERIA						
4. Coliform (fecal)[6], number per 100 ml.	MPN;[6] membrane filter.		922 937		[7](45)	
5. Coliform (fecal)[6] in presence of chlorine, number per 100 ml.	do.[6 7]		922 928, 937			
6. Coliform (total),[6] number per 100 ml.	do.[6]		916 928		[7](35)	
7. Coliform (total)[6] in presence of chlorine, number per 100 ml.	MPN;[6] membrane filter with enrichment.		916 933			
8. Fecal streptococci,[6] number per 100 ml.	MPN;[6] membrane filter; plate count.		943 944 947		[7](50)	
9. Benzidine, milligrams per liter.	Oxidation—colorimetric[8]					
10. Biochemical oxygen demand, 5-d (BOD_5), milligrams per liter.	Winkler (Azide modification) or electrode method.		543		[7](60)	[10](17)
11. Bromide, milligrams per liter.	Titrimetric, iodine-iodate	14		323	56	
12. Chemical oxygen demand (COD), milligrams per liter.	Dichromate reflux	20	550	472	124	[8](610) [10](27)
13. Chloride, milligrams per liter.	Silver nitrate; mercuric nitrate; or automated colorimetric-ferricyanide.	 29 31	303 304 613	267 265	 [10](46)	 [8](615)

See footnotes at end of table.

Parameter and units	Method	1974 EPA methods	14th ed. standard methods	References (page nos.) Pt. 31 1975 ASTM	References (page nos.) USGS methods [9]	Other approved methods
14. Chlorinated organic compounds (except pesticides), milligrams per liter.	Gas chromatography [10]					
15. Chlorine—total residual, milligrams per liter.	Iodometric titration, amperometric or starch-iodine end-point; DPD colorimetric or Titrimetric methods (these last 2 are interim methods pending laboratory testing).	 35	318 322 332 329	 278		
16. Color, platinum cobalt units or dominant wave length, hue, luminance, purity.	Colorimetric; spectrophotometric; or ADMI procedure.[12]	36 39	64 66		92	
17. Cyanide, total,[14] milligrams per liter.	Distillation followed by silver nitrate titration or pyridine pyrazolone (or barbituric acid) colorimetric.	40	361	503	85	[13](22)
18. Cyanide amenable to chlorination, milligrams per liter.	...do	40	376	503		
19. Dissolved oxygen, milligrams per liter.	Winkler (Azide modification) or electrode method.	51 56	443 450	386	126	[5](552)
20. Fluoride, milligrams per liter	Distillation [6] followed by ion electrode; SPADNS; or automated complexone.	 65 59 61	389 391 393 614	 307 305	 93	
21. Hardness—Total, as $CaCO_3$, milligrams per liter.	EDTA titration; automated colorimetric; or atomic absorption (sum of Ca and Mg as their respective carbonates).	68 70	202	161	94	[5](617)
22. Hydrogen ion (pH), pH units.	Electrometric measurement.	239	460	178	129	[5](606)
23. Kjeldahl nitrogen (as N), milligrams per liter.	Digestion and distillation followed by nesslerization, titration, or electrode; automated digestion automated phenolate.	175 165 182	437		122	[5](612)
METALS						
24. Aluminum—Total, milligrams per liter.	Digestion [15] followed by atomic absorption [16] or by colorimetric (Eriochrome Cyanine R).	92	152 171		[11](19)	
25. Aluminum—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced methods for total aluminum.					
26. Antimony—Total, milligrams per liter.	Digestion [15] followed by atomic absorption.[16]	94				
27. Antimony—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total antimony.					
28. Arsenic—Total, milligrams per liter.	Digestion followed by silver diethyldithiocarbamate; or atomic absorption.[16] [18]	 9 95	283 285 159		 [11](31) [11](37)	
29. Arsenic—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total arsenic.					
30. Barium—Total, milligrams per liter.	Digestion [15] followed by atomic absorption.[16]	97	152		82	
31. Barium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total barium.					
32. Beryllium—Total, milligrams per liter.	Digestion [15] followed by atomic absorption [16] or by colorimetric (Aluminon).	99	152 177		83	
33. Beryllium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total beryllium.					
34. Boron—Total, milligrams per liter.	Colorimetric (Curcumin)	13	287			
35. Boron—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total boron.					
36. Cadmium—Total, milligrams per liter.	Digestion [15] followed by atomic absorption [16] or by colorimetric (Dithizone).	101	148 182	345	62	[5](619) [13](37)
37. Cadmium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total cadmium.					
38. Calcium—Total, milligrams per liter.	Digestion [15] followed by atomic absorption; or EDTA titration.	103	148 189	345	66	
39. Calcium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total calcium.					
40. Chromium VI, milligrams per liter.	Extraction and atomic absorption; colorimetric (Diphenylcarbazide).	89, 105	 192		[5]75 75	
41. Chromium VI—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for chromium VI.					
42. Chromium—Total, milligrams per liter.	Digestion [15] followed by atomic absorption [16] or by colorimetric (Diphenylcarbazide).	105	148 192	345 286	78 77	[5](629)
43. Chromium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total chromium.					

See footnotes at end of table.

Parameter and units	Method	References (page nos.)				
		1974 EPA methods	14th ed. standard methods	Pt. 31 1975 ASTM	USGS methods[1]	Other approved methods
44. Cobalt—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]	107	148	345	80	[19] (37)
45. Cobalt—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total cobalt.					
46. Copper—Total, milligrams per liter.	Digestion[13] followed by atomic absorption[15] or by colorimetric (Neocuproine).	108	148 196	345 [illegible]	82	[4] (619) [19] (37)
47. Copper—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total copper.					
48. Gold—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
49. Iridium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
50. Iron—Total, milligrams per liter.	Digestion[13] followed by atomic absorption[15] or by colorimetric (Phenanthroline).	110	148 208	345 [illegible]	102	[4] (619)
51. Iron—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total iron.					
52. Lead—Total, milligrams per liter.	Digestion[13] followed by atomic absorption[15] or by colorimetric (Dithizone).	112	148 215	345	106	[4] (619)
53. Lead—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total lead.					
54. Magnesium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption; or gravimetric.	114	148 221	345	109	[4] (619)
55. Magnesium—Dissolved milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total magnesium.					
56. Manganese—Total milligrams per liter.	Digestion[13] followed by atomic absorption[15] or by colorimetric (Persulfate or periodate).	116	148 225, 227	345	111	[4] (620)
57. Manganese—Dissolved milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total manganese.					
58. Mercury—Total, milligrams per liter.	Flameless atomic absorption.	118	156	[illegible]	[15] (31)	
59. Mercury—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total mercury.					
60. Molybdenum—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]	139		[illegible]		
61. Molybdenum—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total molybdenum.					
62. Nickel—Total, milligrams per liter.	Digestion[13] followed by atomic absorption[15] or by colorimetric (Heptoxime).	141	148	345	115	
63. Nickel—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total nickel.					
64. Osmium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
65. Palladium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
66. Platinum—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
67. Potassium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption, colorimetric (Cobaltinitrite), or by flame photometric.	143	[illegible] [illegible]	[illegible]	134	[4] ([illegible])
68. Potassium—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total potassium.					
69. Rhodium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
70. Ruthenium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15]					
71. Selenium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption.[15] [16]	145	159			
72. Selenium—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total selenium.					
73. Silica—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by colorimetric (Molybdosilicate).	274	487	[illegible]	139	
74. Silver—Total,[20] milligrams per liter.	Digestion[13] followed by atomic absorption[15] or by colorimetric (Dithizone).	146	148 243		142	[4] (619) [19] (37)
75. Silver—Dissolved,[20] milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total silver.					
76. Sodium—Total, milligrams per liter.	Digestion[13] followed by atomic absorption or by flame photometric.	147	[illegible]	[illegible]	148	[4] ([illegible])
77. Sodium—Dissolved, milligrams per liter.	0.45 micron filtration[17] followed by referenced method for total sodium.					

See footnotes at end of table.

Parameter and units	Method	1974 EPA methods	14th ed standard methods	References (page nos.)		Other approved methods
				Pt. 31 1975 ASTM	USGS methods [1]	
78. Thallium—Total, milligrams per liter.	Digestion [13] followed by atomic absorption.[16]	149				
79. Thallium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total thallium.					
80. Tin—Total, milligrams per liter.	Digestion [13] followed by atomic absorption.[16]	150			[11] (65)	
81. Tin—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total tin.					
82. Titanium—Total, milligrams per liter.	Digestion [13] followed by atomic absorption.[16]	151				
83. Titanium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total titanium.					
84. Vanadium—Total, milligrams per liter.	Digestion [13] followed by atomic absorption [16] or by colorimetric (Gallic acid).	153	152 209	441	[11] (67)	
85. Vanadium—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total vanadium.					
86. Zinc—Total, milligrams per liter.	Digestion [13] followed by atomic absorption [16] or by colorimetric (Dithizone).	155	148 210	345	159	[5](619) [10](37)
87. Zinc—Dissolved, milligrams per liter.	0.45 micron filtration [17] followed by referenced method for total zinc.					
88. Nitrate (as N), milligrams per liter.	Cadmium reduction; brucine sulfate; automated cadmium or hydrazine reduction.[21]	201 197 207	423 427 620	446	119	[5](614) [10](28)
89. Nitrite (as N), milligrams per liter.	Manual or automated colorimetric (Diazotization).	215	434		121	
90. Oil and grease, milligrams per liter.	Liquid-liquid extraction with trichloro-trifluoroethane-gravimetric.	229	515			
91. Organic carbon; total (TOC), milligrams per liter.	Combustion—Infrared method.[22]	236	532	467	[20] (4)	
92. Organic nitrogen (as N), milligrams per liter.	Kjeldahl nitrogen minus ammonia nitrogen.	175, 130	437		122	[5] (612, 614)
93. Orthophosphate (as P), milligrams per liter.	Manual or automated ascorbic acid reduction.	249 256	481 624	384	131	[5] (621)
94. Pentachlorophenol, milligrams per liter.	Gas chromatography [19]					
95. Pesticides, milligrams per liter.	do.[19]		555	530	[20] (24)	
96. Phenols, milligrams per liter.	Colorimetric, (4AAP)	241	582	545		
97. Phosphorus (elemental), milligrams per liter.	Gas chromatography [20]					
98. Phosphorus; total (as P), milligrams per liter.	Persulfate digestion followed by manual or automated ascorbic acid reduction.	249 256	476, 481 624	384	130	[5] (621)
RADIOLOGICAL						
99. Alpha—Total, pCi per liter.	Proportional or scintillation counter.		648	591	[11] [23](75+79)	
100. Alpha—Counting error, pCi per liter.	do		648	594	[23] (79)	
101. Beta—Total, pCi per liter.	Proportional counter		648	591	[11] [23](75+78)	
102. Beta—Counting error, pCi per liter.	do		648	598	[23] (79)	
103. (a) Radium—Total, pCi per liter.	do		661	661		
(b) ^{226}Ra, pCi per liter	Scintillation counter		667		[23] (81)	
RESIDUE						
104. Total, milligrams per liter	Gravimetric, 103 to 105° C	270	91			
105. Total dissolved (filterable), milligrams per liter.	Glass fiber filtration, 180° C.	266	92			
106. Total suspended (nonfilterable), milligrams per liter.	Glass fiber filtration, 103 to 105° C.	268	94			
107. Settleable, milliliters per liter or milligrams per liter.	Volumetric or gravimetric		95			
108. Total volatile, milligrams per liter.	Gravimetric, 550° C.	272	95			
109. Specific conductance, micromhos per centimeter at 25° C.	Wheatstone bridge conductimetry.	275	71	120	148	[5] (606)
110. Sulfate (as SO_4), milligrams per liter.	Gravimetric; turbidimetric; or automated colorimetric (barium chloranilate).	 277 279	493 496	424 425		[5] (624) [5] (625)
111. Sulfide (as S), milligrams per liter.	Titrimetric—Iodine for levels greater than 1 mg per liter; Methylene blue photometric.	284	503 505		154	
112. Sulfite (as SO_3), milligrams per liter.	Titrimetric, iodine-iodate	285	508	435		
113. Surfactants, milligrams per liter.	Colorimetric (Methylene blue).	157	600	494	[24] (11)	
114. Temperature, degrees C	Calibrated glass or electrometric thermometer.	286	125		[25] (31)	
115. Turbidity, NTU	Nephelometric	295	132	223	156	

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[1] Recommendations for sampling and preservation of samples according to parameter measured may be found in "Methods for Chemical Analysis of Water and Wastes, 1974" U.S. Environmental Protection Agency, table 2, pp. viii–xii.

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[2] All page references for USGS methods, unless otherwise noted, are to Brown, E., Skougstad, M. W., and Fishman, M. J., "Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases," U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A1, (1970).

[3] EPA comparable method may be found on indicated page of "Official Methods of Analysis of the Association of Official Analytical Chemists" methods manual, 12th ed. (1975).

[4] Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary; however, manual distillation will be required to resolve any controversies.

[5] The method used must be specified.

[6] The 5 tube MPN is used.

[7] Slack, K. V. and others, "Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples: U.S. Geological Survey Techniques of Water-Resources Inv. book 5, ch. A4 (1973)."

[8] Since the membrane filter technique usually yields low and variable recovery from chlorinated wastewaters, the MPN method will be required to resolve any controversies.

[9] Adequately tested methods for benzidine are not available. Until approved methods are available, the following interim method can be used for the estimation of benzidine: (1) "Method for Benzidine and Its Salts in Wastewaters," available from Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[10] American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 1430 Broadway, New York, N.Y. 10018.

[11] Fishman, M. J. and Brown, Eugene, "Selected Methods of the U.S. Geological Survey for Analysis of Wastewaters," (1976) open-file report 76-177.

[12] Procedures for pentachlorophenol, chlorinated organic compounds, and pesticides can be obtained from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[13] Color method (ADMI procedure) available from Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[14] For samples suspected of having thiocyanate interference, magnesium chloride is used as the digestion catalyst. In the approved test procedure for cyanides, the recommended catalysts are replaced with 20 ml of a solution of 510 g/l magnesium chloride ($MgCl_2 \cdot 6H_2O$). This substitution will eliminate thiocyanate interference for both total cyanide and cyanide amendable to chlorination measurements.

[15] For the determination of total metals the sample is not filtered before processing. Because vigorous digestion procedures may result in a loss of certain metals through precipitation, a less vigorous treatment is recommended as given on p. 83 (4.1.4) of "Methods for Chemical Analysis of Water and Wastes" (1974). In those instances where a more vigorous digestion is desired the procedure on p. 82 (4.1.3) should be followed. For the measurement of the noble metal series (gold, iridium, osmium, palladium, platinum, rhodium and ruthenium), an aqua regia digestion is to be substituted as follows: Transfer a representitive aliquot of the well-mixed sample to a Griffin beaker and add 3 ml of concentrated redistilled HNO_3. Place the beaker on a steam bath and evaporate to dryness. Cool the beaker and cautiously add a 5 ml portion of aqua regia. (Aqua regia is prepared immediately before use by carefully adding 3 volumes of concentrated HCl to one volume of concentrated HNO_3.) Cover the beaker with a watch glass and return to the steam bath. Continue heating the covered beaker for 50 min. Remove cover and evaporate to dryness. Cool and take up the residue in a small quantity of 1:1 HCl. Wash down the beaker walls and watch glass with distilled water and filter the sample to remove silicates and other insoluble material that could clog the atomizer. Adjust the volume to some predetermined value based on the expected metal concentration. The sample is now ready for analysis.

[16] As the various furnace devices (flameless AA) are essentially atomic absorption techniques, they are considered to be approved test methods. Methods of standard addition are to be followed as noted in p. 78 of "Methods for Chemical Analysis of Water and Wastes," 1974.

[17] Dissolved metals are defined as those constituents which will pass though a 0.45 μm membrane filter. A prefiltration is permissible to free the sample from larger suspended solids. Filter the sample as soon as practical after collection using the first 50 to 100 ml to rinse the filter flask. (Glass or plastic filtering apparatus are recommended to avoid possible contamination.) Discard the portion used to rinse the flask and collect the required volume of filtrate. Acidify the filtrate with 1:1 redistilled HNO_3 to a pH of 2. Normally, 3 ml of (1:1) acid per liter should be sufficient to preserve the samples.

[18] See "Atomic Absorption Newsletter," vol. 13, 75 (1974). Available from Perkin-Elmer Corp., Main Ave., Norwalk, Conn. 06856.

[19] Method available from Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[20] Recommended methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/l and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to a pH of 12. Therefore, for levels of silver above 1 mg/l 20 ml of sample should be diluted to 100 ml by adding 40 ml each of 2M $Na_2S_2O_3$ and 2M NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/l the recommended method is satisfactory.

[21] An automated hydrazine reduction method is available from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[22] A number of such systems manufactured by various companies are considered to be comparable in their performance. In addition, another technique, based on combustion-methane detection is also acceptable.

[23] Goerlitz, D., Brown, E., "Methods for Analysis of Organic Substances in Water": U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A3 (1972).

[24] R. F. Addison and R. G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," "Journal of Chromatography," vol. 47, No. 3, pp. 421-426, 1970.

[25] The method found on p. 75 measures only the dissolved portion while the method on p. 78 measures only suspended. Therefore, the 2 results must be added together to obtain "total."

[26] Stevens, H. H., Ficke, J. F., and Smoot, G. F., "Water Temperature—Influential Factors, Field Measurement and Data Presentation: U.S. Geological Survey Techniques of Water Resources Inv., book 1 (1975)."

4. In § 136.4, the second sentence of paragraph (c) is amended by deleting the word "subchapter" immediately following the phrase "procedure under this" and immediately preceding the word "shall" and replaced with the phrase "paragraph c;" and § 136.4 is amended by adding a new paragraph (d) to read as follows:

§ 136.4 Application for alternate test procedures.

* * * * *

(c) * * * Any application for an alternate test procedure under this paragraph (c) shall: * * *

(d) An application for approval of an alternate test procedure for nationwide use may be made by letter in triplicate to the Director, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268. Any application for an alternate test procedure under this paragraph (d) shall:

(1) Provide the name and address of the responsible person or firm making the application.

(2) Identify the pollutant(s) or parameter(s) for which nationwide approval of an alternate testing procedure is being requested.

(3) Provide a detailed description of the proposed alternate procedure, together with references to published or other studies confirming the general applicability of the alternate test procedure to the pollutant(s) or parameter(s) in waste water discharges from representative and specified industrial or other categories.

(4) Provide comparability data for the performance of the proposed alternate test procedure compared to the performance of the approved test procedures.

§ 136.5 [Amended]

5. In § 136.5, paragraph (a) is amended by inserting the phrase "proposed by the responsible person or firm making the discharge" immediately after the words "test procedure" and before the period that ends the paragraph.

6. In § 136.5, paragraph (b) is amended by inserting in the first sentence the phrase "proposed by the responsible person or firm making the discharge" immediately after the words "such application" and immediately before the comma. The second sentence of paragraph (b) is amended by deleting the phrase "Methods Development and Quality Assurance Research Laboratory" immediately after the phrase "State Permit Program and to the Director of the" at the end of the sentence, and inserting in its place the phrase "Environmental Monitoring and Support Laboratory, Cincinnati."

7. In § 136.5, paragraph (c) is amended by inserting the phrase "proposed by the responsible person or firm making the discharge" immediately after the phrase "application for an alternate test procedure" and immediately before the comma; and by deleting the phrase "Methods Development and Quality Assurance Laboratory" immediately after the phrase "application to the Director of the" and immediately before the phrase "for review and recommendation" and inserting in its place the phrase "Environmental Monitoring and Support Laboratory, Cincinnati."

8. In § 136.5, the first sentence of paragraph (d) is amended by inserting the phrase, "proposed by the responsible person or firm making the discharge," immediately after the phrase, "application for an alternate test procedure," and immediately before the comma.

The second sentence of paragraph (d) is amended by deleting the phrase, "Methods Development and Quality Assurance Research Laboratory," immediately after the phrase, "to the Regional Administrator by the Director of the," and immediately preceding the period ending the sentence and inserting in its place the phrase, "Environmental Monitoring and Support Laboratory, Cincinnati."

The third sentence of paragraph (d) is amended by deleting the phrase, "Methods Development and Quality Assurance Research Laboratory," immediately after the phrase, "forwarded to the Director," and immediately before the second comma and by inserting in its place the phrase, "Environmental Monitoring and Support Laboratory, Cincinnati."

9. Section 136.5 is amended by the addition of a new paragraph (e) to read as follows:

§ 136.5 Approval of alternate test procedures.

* * * * *

(e) Within ninety days of the receipt by the Director of the Environmental Monitoring and Support Laboratory, Cincinnati of an application for an alternate test procedure for nationwide use, the Director of the Environmental Monitoring and Support Laboratory, Cincinnati shall notify the applicant of his recommendation to the Administrator to approve or reject the application, or shall specify additional information which is required to determine whether to approve the proposed test procedure. After such notification, an alternate method determined by the Administrator to satisfy the applicable requirements of this part shall be approved for nationwide use to satisfy the requirements of this subchapter; alternate test procedures determined by the Administrator not to meet the applicable requirements of this part shall be rejected. Notice of these determinations shall be submitted for publication in the FEDERAL REGISTER not later than 15 days after such notification and determination is made.

[FR Doc.76-35082 Filed 11-30-76;8:45 am]

2. Announcing the Course

a. Course Availability

Course availability is most likely to be established through one of two mechanisms:

1) Management or regulatory authority determines that training is required, makes arrangements for course presentation and instructs designated personnel to appear at a specified time and place for training; or,

2) The course may be planned by a training organization which schedules and publicly announces the course either as a special offering or as an element of an overall curriculum of training.

b. Responsibility for Course Announcement

All training organizations should establish and maintain mailing lists of officials, organizations and interested individuals to whom training announcements should be addressed.

Course announcements should be released by the training organization and/or the sponsoring agency (if applicable).

When a special course offering is planned at the request of management or regulatory authority with identified class participants, it usually is best for the requesting authority to make the announcement.

c. Types of Course Announcements

1) Training bulletins, or catalogues are widely used by established training organizations, and should be used for announcement of this course when offered as part of an on-going curriculum of courses.

2) Special fliers or brochures should be developed for public announcement through established mailing lists. These releases may be used for regular offerings of an on-going curriculum of courses; but they are particularly applicable when a special offering of the course is planned.

3) The course may be announced in a journal, newsletter or other periodical widely read by the personnel for whom the training is intended.

4) The course may be announced by personal letter or other direct communication with a student assigned to take the training.

d. Timing of Course Announcements

Training catalogues or bulletins usually are for a period of one year or more. Accordingly, the prospective student should have from three months to one year of advance notice of the training.

When the course is a special offering announced through a flier or other special mechanism, at least 90 days should be provided between the release of the announcement and the start of the course. There are at least two reasons for this:

1) Permits course applicants to secure necessary approvals for attendance, and to make personal scheduling arrangements; and,

2) Provides course presentation staff with lead time for course preparations, acquiring special instructional materials, preparation of laboratory supplies and equipment, and related tasks.

e. Information Provided in Course Announcements

The following list should be helpful as a checklist to those preparing a course announcement. Samples of an announcement for this course as it might appear in a catalogue of courses, and as it might appear in a special flier are shown in Part I, C of this Guide, under SECRETARIAL SUPPORT.

In the event that the course is announced in a periodical, the editor may apply constraints on style and format which make it impossible to provide all the pertinent information on the course. In such cases the announcement must provide the name and address of an office from which further information can be obtained. The information to be provided should be as complete as that given in a course catalogue or flier and, naturally, should include any additional special information specifically requested.

The following will be helpful as a checklist to those preparing an original course announcement:

1) Course title, dates and location

2) Name of organization conducting the course (and name of co-sponsor, if applicable)

3) Description of intended student body, reason why this training is needed and summary of Course content.

4) Prerequisites for attendance (special skills or training which the applicant must have for admission)

5) Description of the training environment to be used (classroom, laboratory, field, in-plant, etc.)

6) Identification of knowledge and skills the participant will have on satisfactory completion of training

7) Tuition (if applicable)

8) How and where to apply for admission to this course

3. Summary Plan for the Course

A convenient format to use in the early stages of devising a course plan is a day-to-day assignment of time blocks based on estimates by authors of the training time required for each parameter. (An example is on the next page.) Using available time as a first criterion will allow a variety of possible sequences. Then other considerations should be applied. Some examples are:

a. If some equipment must be used in more than one test, schedule another topic between the two tests to allow time for the required clean-up.

b. Schedule the topics so each instructor alternates between prime and assistant responsibilities to allow time for preparations which must be done right before training sessions.

c. If one procedure requires skills taught in another procedure, order the presentations accordingly.

d. If most students need only 80% of the procedures taught, schedule the remaining 20% of the procedures as a group so students can conveniently schedule their attendance for training pertinent to their needs.

SELF-MONITORING PROCEDURES: BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS

Summary Plan for Course

Monday		Tuesday		Wednesday		Thursday		Friday	
Activity	Time Hours	Activity	Time Hours	Activity	Time Hours	Activity	Time Hours	Activity	Time Hours
Registration Course Coordinator	1/4	Use of the DO Probe Chemist	2	Evaluation of Student Performance Engineer	3/4	Evaluation of Student Performance Engineer	3/4	Evaluation of Student Performance Engineer	3/4
Course Objectives and Organization Course Coordinator	1/4	pH Chemist	1-1/2	Flow Measurements Parshall Flume Weir Engineer	3-1/4	Suspended Solids Chemist	4-1/4	Fecal Coliform Geometric Mean Microbiologist	2
Permit Requirements Engineer	1/2	Fecal Coliform Microbiologist	4-1/2	Residual Chlorine Chemist	2	Bacteriological Sampling Microbiologist	1/2	BOD_5 (Continued) Chemist	3/4
BOD_5 Chemist	5-3/4			Fecal Coliform (Continued) Microbiologist	1-1/2	General Principles of Sewage Sampling Engineer	1	Suspended Solids (Continued) Chemist	1/4
						Fecal Coliform (Continued) Microbiologist	1-1/4	Reporting Monitoring Data Engineer	2
								Course Closing Exercises All Staff	1/4

NOTES:

1. Program time only is shown. Additional time required for lunch and breaks.
2. Leading instructor only is designated. Other instructors will provide support to leading instructors for all laboratory instruction.

(Sample Schedule)

SELF-MONITORING PROCEDURES -
BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS (164.1)
(Location)
(Dates)

Course Coordinator:

DAY & TIME	SUBJECT	INSTRUCTOR *
Monday		
8:30 - 8:45	Registration	Course Coordinator
8:45 - 9:15	Course Objectives & Organization	Course Coordinator
9:15 - 9:30	Permit Requirements	Engineer
9:30 - 9:45	Break	
9:45 - 4:30	5-Day BOD Test (Break & Lunch at time designated by instructor)	Chemist
Tuesday		
8:30 - 9:15	Evaluation of Monday's Performance	Engineer
9:15 - 9:30	Break	
9:30 - 11:00	pH	Chemist
11:00 - 12:00	Fecal Coliform	Microbiologist
12:00 - 1:00	Lunch	
1:00 - 4:30	Fecal Coliform (Continued)	Microbiologist
Wednesday		
8:30 - 9:15	Evaluation of Tuesday's Performance	Engineer - Staff
9:15 - 9:30	Break	
9:30 - 12:30	Flow Measurements Parshall Flume Weir	Engineer
12:30 - 1:30	Lunch	
1:30 - 2:30	Flow Measurements (Continued	Engineer
2:30 - 4:00	Residual Chlorine	Chemist
4:00 - 5:00	Fecal Coliform (Continued)	Microbiologist

*NOTE: For actual course presentation, insert the name of the instructor instead of the technical specialty, as shown.

Agenda

DAY & TIME	SUBJECT	INSTRUCTOR
Thursday		
8:30 - 9:15	Evaluation of Wednesday's Performance	Engineer - Staff
9:15 - 9:30	Break	
9:30 - 12:00	Suspended Solids	Chemist
12:00 - 12:45	Lunch	
12:45 - 2:45	Suspended Solids (Continued)	Chemist
2:45 - 4:00	Fecal Coliform (Continued)	Microbiologist
4:00 - 5:00	General Principles of Sewage Sampling	Engineer
Friday		
8:30 - 9:15	Evaluation of Thursday's Performance	Engineer - Staff
9:15 - 9:30	Break	
9:30 - 11:30	Fecal Coliform: Geometric Mean	Microbiologist
11:30 - 12:30	5-Day BOD Test (Concluded)	Chemist
12:30 - 1:30	Lunch	
1:30 - 1:45	Suspended Solids (Concluded)	Chemist
1:45 - 2:30	Reporting Self-Monitoring Data	Engineer
2:30 - 2:45	Course Closing Exercises	All Staff

5. Milestones in Course Planning and Preparation

The following pages list major areas of course responsibilities in a chronological order to facilitate efficient and timely accomplishment. The table also serves as an example for assignment of these responsibilities to various staff members. The chapter number in the Staff Guide is given for each task so that the user can quickly find the details about his/her assignments.

The table headings are job titles associated with the designated tasks. A maximum staff is cited, including a laboratory assistant. It is recognized; however, that the staff often is limited, and one individual may serve in several of the defined roles. Showing this summary according to an idealized situation should facilitate an equitable division of the required tasks among a smaller task.

About three months before the course, final decisions must be made regarding specific procedures to be taught, because several of the Effluent Monitoring Procedures (EMPs) offer a choice of methods. The milestone charts on the following pages are comprehensive, covering all the procedures available for this course. Naturally, the identified tasks will be limited to the parameters and the methods selected for inclusion in the individual course offering.

Special requirements associated with the NPDES permits, special requirements of the State, and/or the type of equipment readily available will help the course planners to make choices among the various available alternatives.

	Training Supervisor	Course Coordinator	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
5 TO 6 MONTHS BEFORE COURSE								
Determination of the need and decision to have course.	x							1, 2
Designation of Course Director and Course Secretary.	x							
Review responsibilities.		x						PREFACE, 1 thru 12
Review responsibilities.			x					PREFACE, 1, 6, 10, 11, 12
Commit classroom and laboratory facilities.	x	x						7
Develop and release Course Announcement including location date, general statement of course content and training objectives.		x	x					2, 12
Prepare all forms and information sheets related to student registration procedures.		x	x					10, 11, 12
Decide on staff members.	x	x						6
4 TO 5 MONTHS BEFORE COURSE								
Receive, review, act upon Course Applications, continuing until course begins.		x	x					10, 11, 12
Maintain records on deposition of each application, continuing through course.			x					10, 11, 12
Inventory Staff Guides, Order needs.		x	x					9

	Training Supervisor	Course Coordinator	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
3 MONTHS BEFORE COURSE								
Commit all staff members who will participate in Course.	x	x		x	x	x	x	6
Develop Milestone Checklist for specific Course.		x	x					5
Distribute copies to staff of Milestones, Staff Guide, Student Text and any other pertinent training resources.	x	x	x					5, 9
Review responsibilities.				x	x	x	x	PREFACE, 1, 6, 10, 12
Assign topics to Primary (P) and Assistant (A) Instructors:	x	x						
Permit Requirements				P	A			
BOD_5				A		P	A	14, 16
Use of DO Probe				A		P	A	17, 18
pH				A		P	A	19
Fecal Coliform					P		A	21, 22
Flow Measurement				P			A	24, 25
Residual Chlorine				A		P	A	26, 27, 28
Suspended Solids				A		P	A	29, 30
Sampling				P	A	A		14 to 20 incl, 26 - 30
Geometric Mean				A	P			23
Reporting Monitoring Data				P	A	A		31
Evaluation of Student Performance				P	A	A		14 - 30 incl
Decide which procedures to teach if EMP has choices. Record on related IPW.	x	x		x	x	x	x	8 and 13 thru 30
Mark which procedures are to be taught on the summary of laboratory equipment and supply needs for course.		x		x	x	x	x	8
Develop summary plan for course.		x	x	x	x	x	x	3

	Training Supervisor	Course Coordinator	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
Inventory chemicals and laboratory equipment/supplies. List and commit lending sources. Order rest of needs.		x	x	x	x	x	x	8
Inventory classroom equipment/supplies. List and commit lending sources. Order rest of needs.		x	x					7
Inventory student reference texts. Order needs.		x	x					9
2 MONTHS BEFORE COURSE								
Finalize Course Schedule (Agenda).		x	x	x	x	x	x	4
Request laboratory/classroom needs from lending sources.		x	x	x	x	x	x	7, 8
Request training aids from lending sources.		x	x	x	x	x	x	9
6 WEEKS BEFORE COURSE								
Check out operation of all items listed as "A", Capitol Equipment."				x	x	x	x	8
Primary and Assistant Instructors go through EMP laboratory procedures in student reference text, using IPW's to standardize instructions for students.				x	x	x		14 through 30
1 MONTH BEFORE COURSE								
Summary (to date) to staff of registered students, continuing to course beginning.		x	x					

	Training Supervisor	Course Director	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
Check on progress of staff preparations for instruction, continuing through course.		x		x	x	x		6
Prepare all administrative forms and materials needed for course presentation.		x	x					10, 11, 12
Plan and rehearse classroom presentations using all required training aids. Finalize.				x	x	x		13 through 31
Obtain any duplicated instructional materials (data sheets, etc.)			x	x	x	x	x	12, and 13 thru 30
Review summary of laboratory equipment and supply needs for expected number of students doing the selected procedures.		x					x	8
Clean all glassware required by students. ((Special for Phosphorus, COD, Ammonia (distillation apparatus))							x	8, 14, 15, 16, 17, 18
Reserve all specially-cleaned glassware.							x	8, 14, 15, 16, 17, 18
Assemble other student equipment and supplies.							x	8
2 WEEKS BEFORE COURSE								
Arrange for security of classroom and laboratory.		x	x					7
Make reagents required by students EXCEPT those with specified, limited stability.				x	x	x	x	8 and 14 thru 30
Make final arrangements to obtain required effluent samples.				x	x	x	x	8 and 14 thru 30

	Training Supervisor	Course Director	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
Determine range of concentration of desired constituent in effluent sample from source of course samples.				x	x	x		8 and 14 thru 30
Give Laboratory Assistant final list of equipment and supplies to be at each laboratory position. Discuss arrangement of shared equipment.				x	x	x	x	14 through 22; 27thru 30
1 WEEK BEFORE COURSE								
Inform building food service of number of expected students and course lunch times (as appropriate).			x					
3 DAYS BEFORE COURSE								
Finalize seating arrangement for classroom.		x						7
Assemble course materials in classroom (student texts, administrative materials, etc.). Distribute as appropriate.		x	x					9, 10, 11, 12
Ready classroom instructional aids (boards, erasers, etc.).		x	x				x	7
Check out all classroom equipment (electrical systems, PA, projection equipment) and obtain back-up accessories (bulbs, etc.).		x						7
COURSE OPENING								
Conduct opening exercises.		x						6
Participate in course opening.	x		x	x	x	x	x	6
Complete any required student records, including roster.		x	x					10, 11, 12

(Continued)

	Training Supervisor	Course Director	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
Prepare course certificates and give to Day's Instructor.			x					10, 12
EVERY DAY OF COURSE								
Maintain general supervision of course.		x						6
Prepare unstable reagents and/or samples on day of test.				x	x	x	x	8, 14-30 as applicable
Obtain effluent samples for each test on day of test.				x	x	x	x	8, 14-30, as applicable
When assistant instructor, make any student evaluation records requested by the lead instructor.				x	x	x		1, 6, 12, 14 thru 30
When primary instructor, compile evaluation record for each student.				x	x	x		1, 6, 12, 14 thru 31
When primary instructor, sign certificate of each student who satisfactorily performs test.				x	x	x		1, 12, 14 thru 30
After signing certificates, give them to next primary instructor.								
When primary instructor, make arrangements to work with each non-qualifying student.				x	x	x		1, 14 thru 31
SECOND-LAST DAY OF COURSE								
Distribute course critique sheet to students.		x						

	Training Supervisor	Course Coordinator	Course Secretary	Engineer	Microbiologist	Chemist	Lab Assistant	Refer to Staff Guide Outline No.
LAST DAY OF COURSE								
Assemble certificates, check for completeness and sign.		x						12
Collect students' critique sheets.		x						
Conduct closing exercises and distribute certificates.		x						6
Participate in course closing.	x		x	x	x	x	x	6
Clean up classroom and laboratory.		x	x	x	x	x	x	6
WITHIN A WEEK OF COURSE PRESENTATION								
Return or replace any borrowed classroom equipment/supplies.		x	x					7
Return or replace any borrowed laboratory equipment/supplies.				x	x	x	x	8
Return or replace any borrowed training aids.		x	x	x	x	x		9
Order repairs or replacements of own equipment used in course.		x	x	x	x	x		7, 8, 9
File evaluation records on all student in predetermined area.			x	x	x	x		10
Participate in staff session on evaluation of course and recommendations for future offerings.	x	x	x	x	x	x	x	6, 10
Prepare course summary/evaluation report.		x						6
Complete and file entire course records in mutually determined area		x	x					10, 11, 12

B. Training Resources

This section considers four topics: Training Staff, Training Facilities, Laboratory Equipment and Supply Requirements, and Instructional Resources.

Staffing plans, facilities, equipment and supplies described in this Guide are based on a class of 18 students. Equipment and supply resources must be increased proportionately. For at least the first several (3 or 4) course offerings, it is urged that this maximum number of students per class be strictly adhered to.

A staff experienced in presentation of this course may be able to increase class size to, say, 24 students. On no account should this laboratory-oriented course exceed 24 students with an instructional staff of the size described here. Large numbers of students per instructor simply cannot be provided with the individual attention and instruction required for effective training and assurance that they have indeed learned to perform the analyses which are the subject of this course.

If the number of workers requiring this course is quite large, the best course of action is to meet the training need through providing a greater number of course offerings.

The required instructional resources, shown in outline 9, are compiled from the individual instructional package worksheets shown in Part II. Training administrators should coordinate requests for instructional resources to be acquired, through loan or through purchase, from other sources. This outline provides a basis for such coordination.

1. Training Staff

Each member of the training staff for this, as for any short course, is a member of a team. This team can function effectively only through each member's understanding of the training goals to be met and the plans for meeting these goals, through performance of his/her own duties, and through providing mutually supportive activity with other team members for the effective conduct of the course as a whole.

a. Qualifications of Instructional Staff

1) Each should have a thorough knowledge of the subject matter for which he/she has responsibility, including a high order of technical skill in any procedures to be carried out.

2) Each should be able to perform effectively as an instructor, both in the classroom and in the laboratory. This includes ability to make rapid adjustments in the style and technical level of instruction in order to work with students having a varied range of entry-level knowledge, skills, and prior education.

3) Each should be willing to accept a certain rigidity in the choice of analytical procedures to be taught, in accordance with policies

and formal directives of the applicable regulatory authority (-ies). The basis for, and recommended procedures to be followed, in introducing variations in methods to be taught in tests and measurements of municipal effluents is discussed elsewhere in this Guide.

b. Estimated Time Allocations for Training Staff

Each member of the training staff has specific duties before, during, and after the scheduled course dates. For planning purposes, it is assumed that pre-course activity will begin three months or more, as required, before classroom instruction begins. During this period, the estimated time allocations will permit the phasing-in of work activity for this course with other duties of all personnel. During the course, all instructional staff and laboratory assistant (if used) are fully occupied, and should not be given any other duty assignments. Post-course activities should be completed within one or two weeks after the last day of instruction. In the post-course period, all staff may begin to phase in other duties pending final completion of all details associated with this training effort.

Staff Identification	Working Days (estimate)		
	Before	During	After
Course Administration			
Course Coordinator (ordinarily, this is one of the instructional staff, who is assigned double-duty as coordinator-instructor)	12	1	2
Course Secretary (1)	10	2	2
Instructional Staff			
Chemist (1)	10	5	2
Engineer (1)	5	4	2
Microbiologist (1)	10	5	2

c. Duties and Responsibilities of Training Staff

1) Course Coordinator

This individual may be known variously as Course Director, Course Leader, or by some other term suitable to the situation. In most cases the Course Coordinator will function in a dual capacity as one of the instructional staff for the course. In principle, any one of the Instructors could function as Course Coordinator. In the absence of other factors, it may be best to have the individual who bears the lightest teaching load to act as Course Coordinator.

a) Before the course, the Coordinator receives assignment from management to lead the course, after which he/she:

   (1) Obtains commitment of the other members of the training team for the course, including Secretary, Instructors, and (if used) Laboratory Assistant;

   (2) Determines the composition and geographic origin of the student body to be trained;

   (3) Develops a working schedule and specific staff assignments for all significant milestone stages of course preparation and implementation;

   (4) Meets with course staff, distributes instructional guides and related training materials, and reviews the preparation plans and day-to-day working schedule; assigns specific topics and time allocation for which each Instructor has prime instructional responsibility and for which each Instructor serves as assistant to prime Instructor;

   (5) Identifies which, if any, available options in procedures should be taught for compliance with directives of the governing regulatory authority (-ies);

   (6) Prepares announcement of the course, and distributes it as appropriate to the potential student body;

   (7) Reviews classroom and laboratory facilities, making arrangements for any required repairs or adaptations;

   (8) In consultation with Instructors, reviews availability and condition of all equipment, supplies, and other training resources required for the course, and makes timely arrangements for repair and maintenance, reorder, or borrowing of needed items;

   (9) Arranges for supplies of student reference texts and associated training materials;

   (10) Works with Secretary in registration of students and in all pre-course communications on schedules, local housing and transportation, and other pertinent matters;

   (11) If the course is to be conducted in a "field" location, coordinates timely arrangements for staff travel, transportation of equipment and supplies, arrangements for training facilities, local housing and transportation, determination of availability and location of dining facilities, and any other preparations required for course conduct away from normal base location;

(12) Initiates periodic and timely checks with other training team members to assure that their pre-course preparations are on schedule and that preparation of required resources is moving ahead according to plan. Takes action as necessary to identify problems and to expedite solutions as the need arises;

(13) Represents the training team in all formal communications with management, host organizations, students, and with commercial or private sources of equipment and supplies.

b) During the course, the Course Coordinator:

(1) Takes charge of course opening exercises including student registration, welcome and staff introductions. Presents and discusses course objectives;

(2) Maintains general supervision of course, assuring that all activities are kept on schedule; maintains liaison between staff members and other interfacing organizations/individuals as necessary;

(3) Maintains consolidated summary record of student performance based on information provided by other Instructors; with staff determines which students should/should not be recorded as having satisfactorily met training objectives;

(4) Provides Course Secretary with timely information necessary for preparation of course certificates; signs course certificates as representative of the course training staff;

(5) Presides over course closing activities, including award of certificates.

c) After the course, the Course Coordinator:

(1) Reviews and evaluates with the instructional staff all matters considered pertinent to the effective implementation of the course as planned, developing proposals and plans for adjustments as necessary for future offerings of the course;

(2) Orders repair, renovation, and replacement of any equipment or supplies that require such attention;

(3) Coordinates return of any borrowed resources used in the course;

(4) If course was conducted in the field, coordinates repacking and return shipment of all equipment and supplies;

(5) Drafts course summary/evaluation report;

(6) Prepares and forwards any reports required by other supervising, coordinating, or financing authority.

2) Course Secretary

The Course Secretary works under the direct supervision of the Course Coordinator, and prepares or arranges preparation of all formal communications, procurement documents, training materials, and records required for course preparation and implementation. The Course Secretary also provides office support work for the course instructional staff in all matters pertaining to course preparation and implementation.

a) Before the course, the Course Secretary:

(1) Works with the Course Coordinator in identification and preparation of copies of all pertinent course materials for use in planning conferences between Course Coordinator and the instructional staff, including Instructors' copies of working schedules for course preparation, course agenda from preliminary to final draft, staff assignments, Instructors' instructional package worksheets, all student instructional materials and associated data sheets, student evaluation sheets, quizzes, and any other typed or printed material projected for course use;

(2) After Course Coordinator's conference with instructional staff, and resolution of decision making issues, arranges for printing (or reproduction) and assembly of all materials indicated under (1) above, in a quantity adequate for projected course requirements;

(3) Arranges for printing or reproduction, and distribution of the projected course announcement as directed by Course Coordinator;

(4) Serves as Registrar, maintaining roster and records of students submitting application and accepted for admission to the course, prepares routine response to students announcing acceptance with information as appropriate on course dates and schedule, local "geography" including key addresses, hotel/motel/dining information, local transportation information, and any other information which will simplify personal planning of registered students;

(5) Prepares, or arranges for, all individual student supplies, including registration cards, course manuals, note paper, pencils, name tags (1 for wearing and 1 for use at classroom seating position), course certificates, etc.;

(6) Prepares orders or procurement requests for equipment and supplies needed for the course based on specifications provided by the instructional staff;

(7) If the course is a "field" presentation, makes arrangements for shipment of equipment and supplies to course site and return, staff travel schedules and order of tickets, hotel reservations, and associated functions;

(8) Prepares the classroom for use in the course, including distribution of individual student materials to seating positions, arrangements for classroom organization of audiovisual projection or playback equipment, chalkboards and associated supplies, and other classroom needs. (Ordinarily, the Course Secretary does not travel to a "field" presentation; this function will have to be provided through special arrangements with the host organization at the course site.)

b) During the course, the Course Secretary functions as an "unofficial staff hostess," and:

(1) Attends course opening exercises, assisting students in completion of registration cards and associated records;

(2) Prepares course summary registration information, prepares class roster on first day of course and distributes copies to students and instructors, keeping copies for future records;

(3) Provides clerical/secretarial support to Course Coordinator and instructional staff as required;

(4) Receives incoming mail and messages for staff and students, expediting communications to extent practical and feasible;

(5) Prepares course certificates as specified by Course Coordinator on last day of course;

(6) Inspects classroom daily, making arrangements as necessary for coordination of deficiencies in janitorial services, and personally corrects minor deficiencies to extent feasible;

(7) Attends and participates in course closing exercises.

c) After the course, the Course Secretary:

(1) Prepares typed copy of all reports drafted by the Course Coordinator, and forwards reports as indicated;

(2) Places purchase orders or procurement requests for repair, renovation, or replacement of equipment and supplies as directed by Course Coordinator;

(3) Removes all course supplies from the classroom, returns borrowed resources, leaves classroom in condition suitable for use by following class (this does not imply janitorial services!);

(4) If course is conducted on a repetitive basis, inventories all consumable classroom supplies including data sheets, worksheets, quizzes, course schedules, and the like, and reorders or provides for reproduction of any items coming into short supply.

3) Instructor (Chemistry, Engineering, Microbiology)

a. Before the course, each instructor receives course duty assignment from management; and,

(1) Meets with Course Coordinator for discussions of course plans, objectives, and for development of day-to-day course preparation schedule;

(2) In conference with Course Coordinator determines which of any options in tests and measurements will be taught, determines lesson guides to be followed and student reference materials to be used, and resolves any other problems on instructional materials, their content, and related matters which should be determined beforehand;

(3) Reviews requirements for equipment, supplies, audiovisual training aids, and other training resources to be used in individual instructional assignments. Performs equipment upkeep and maintenance procedures, prepares supplies and reagents required to be available for student use. Provides Course Coordinator with timely, detailed information on specifications for all equipment, supplies, and other training resources which must be purchased, rented, or borrowed for the course;

(4) If the course is to be conducted in a "field" location, packs equipment and supplies for shipment so that they will arrive at destination in good condition; identifies to the Course Coordinator the equipment and supplies which should not or cannot be shipped which should be provided otherwise at the course site;

(5) Rehearses all classroom and laboratory instructional presentations to the extent necessary to assure effective performance within the scheduled time allocation;

(6) Reviews and practices all tests and measurements for which he/she has responsibility as leading instructor to assure personal proficiency and adequacy of pre-course plans and preparations; supervises pre-course practice of other instructors who will serve as assistant instructors for specified procedures;

(7) Serves as assistant instructor for specified tests and measurements, developing personal proficiency through pre-course practice under supervision of the applicable leading instructor, and teaches the tests and measurements in accordance with techniques specified by the leading instructor; and

(8) Reports periodically as requested to the Course Coordinator on status of course preparations, and cooperates in working out timely procedures for their solution.

b. During the course, the instructor designated "chemist";

(1) Attends and participates in course opening exercises.

(2) Serves as leading instructor for the following tests and measurements: BOD_5, and related subjects, pH, chlorine, measurement and solids determinations. In this capacity the chemist is responsible for all classroom instruction on the designated subjects, leadership of all laboratory instruction, collection of (or arrangements for) samples for laboratory examination by class, student performance evaluation and associated records for submission to Course Coordinator, and student counseling on pertinent matters related to area of personal responsibility.

(3) Attends and participates in all classroom start-of-day evaluation sessions on previous day's student performance.

(4) Assists leading instructor in laboratory instruction phases of fecal coliform test and flow measurements, including preparation and organization.

(5) Attends and participates in course closing exercises.

c. During the course, the instructor designated "engineer";

(1) Usually functions also as Course Coordinator (see duties described separately).

(2) Attends and participates in course opening exercises.

(3) Serves as leading instructor for the following instructional elements in the course:

permit requirements, flow measurement, sample collection, and the reporting of monitoring data.

(4) Presides at classroom review and evaluations at start of each day's program.

(5) Assists other instructional staff wherever possible, particularly in laboratory instructions, in sample collections for class use and in preparation for changes from laboratory function to another.

(6) Attends and participates in course closing exercises.

d. During the course, the instructor designated "microbiologist";

(1) Attends and participates in course opening exercises.

(2) Serves as leading instructor for the following subjects: bacteriological sampling, fecal coliform tests, fecal coliform geometric mean determination. In this capacity the microbiologist is responsible for all classroom instruction on the designated subjects, leadership of all laboratory instruction, collection of (or arrangements for) samples for laboratory examination by class; student performance evaluation and associated reports for submission to Course Coordinator, and student counseling on pertinent matters related to area of personal responsibility.

(3) Attends and participates in all classroom start-of-day evaluation sessions on previous day's student performance.

(4) Assists leading instructor in laboratory instruction phases of BOD_5, pH, residual chlorine, and suspended solids, including laboratory preparation and organization.

(5) Attends and participates in course closing exercises.

e. After the course, all instructors;

(1) Review the course implementation experience with the the Course Coordinator, mutually developing proposals and plans for adjustments as necessary for future offerings of the course.

(2) Evaluates condition of all equipment and supplies, initiating action to repair, renovate, or replace any items found deficient or in short supply.

(3) Takes necessary action to put laboratory into state of neatness and order for occupancy of the next course (this does not imply janitorial service!).

(4) If course was conducted in the field, repacks all equipment and supplies for return to home institution, after at least superficial cleaning of all dirty or contaminated glassware.

(5) On return of shipment to home institution, unpacks all equipment and supplies, returning it to designated custodial site, including return of borrowed equipment and other returnable resources.

f. Laboratory Assistant

The Laboratory Assistant is designated as "optional" in the staffing plan, but services of a laboratory assistant are strongly recommended. This is particularly urged in a fixed training installation where this and other courses are being conducted on a continuing or repetitive basis. The laboratory assistant works particularly in support of the instructional staff. The assistant will be given routine tasks which will free the instructional staff for more specialized or complicated tasks associated with the planning, preparation, and implimentation of the training.

g. Before the course, the Laboratory Assistant;

(1) Works closely with the instructional staff members, performing standardized tasks as specified in the course preparation plan. These duties will fall primarily under items 3, a, (3) and (4).

(2) Organizes laboratory supplies and equipment for each procedure in such a way as to permit distribution to the students or to their working sites with maximum efficiency during the course presentation.

(3) Assists Course Secretary wherever feasible in assembly and organization of student instructional materials, classroom preparation and related tasks.

h. During the course, the laboratory assistant;

(1) Performs all possible tasks in support of leading instructors in setting up student work positions, collecting and returning used glassware, supplies and equipment, etc., to central repository.

(2) Cleans and maintains all glassware and supplies other than those stipulated for student performance.

(3) Notifies leading Instructor promptly of any noted discrepancies or deficiencies in supplies, equipment, or planning which leads to problems in implementing the course.

(4) In field courses, packs equipment in shipping cases as rapidly as its use has been completed for the course.

i. After the course, the Laboratory Assistant;

(1) Assists Instructors in all equipment and supply inspection, renovation and return to proper location.

(2) Puts laboratory in state of neatness and order preparatory to use for next class.

(3) Prepares any stable supplies required for next offering of the course, within limits of technical capability.

2. Training Facilities and Related Equipment

This course requires both a classroom and a laboratory for class use. Effective presentation of the course requires staff attention to many details related to these facilities. Problems more often occur in field courses (i.e., away from "home base"). In any location it is unusual that all desired features of a training facility will be met, but with timely attention most problems can be solved or at least partially resolved.

a. General Considerations

1) Spatial Relationships

Classroom and laboratory should be separate, but close together. Much of the instruction requires frequent shifts between classroom and laboratory. Therefore, the classroom and laboratory must not be in separate buildings, and should not be far apart within any structure.

2) Associated Comforts

a) The classroom and the laboratory should have a comfortable temperature, be free of obvious drafts, be well-ventilated, and should be well-lighted. It is, of course, possible to develop specifications for acceptable temperature ranges, light intensity ranges, humidity, etc.; but there is no substitute for exercise of good judgment.

b) Suitable restroom and drinking fountain facilities should be convenient to the classroom and laboratory.

c) Smoking:

(1) NO SMOKING IN THE LABORATORY. There should be no compromise on this.

(2) Some schools permit smoking in the classrooms. If this is the practice, it is advisable to locate ashtrays so that smokers sit in an area where their smoking will not disturb others.

3) Lunchroom Facilities

Most schedules for this course will allow a one-hour lunch break. It is advisable that the course staff identify and make known to the class the names and locations of convenient dining facilities where service, variety, quality, and price are satisfactory.

4) Comments to Class about Facilities

a) On the first day of the course the general orientation should include such information as the class needs on the location and use of facilities and conveniences for class use.

b) It is strongly urged that the entire strining staff never at any time indulge in apologies or criticisms of the classroom or laboratory facilities being used. Such remarks serve no useful prupose and can only detract from an effective program, provided that everything possible has been done beforehand to resolve existing problems with facilities. Student comments and complaints should be given an honest repsonse, but such comments from students should not be regarded as an excuse for staff to enlarge on the subject.

b. Classroom

1) General Features

a) Door at rear of room is preferred; this permits entry of latecomers without excessive distraction of class.

b) The classroom should be free from excessive extraneous noises, such as from construction projects, heavy traffic, or from aircraft.

c) The classroom should have adequate electric power outlets (115 V) for use of audiovisual equipment. The receptacles should be inspected for assurance that they are compatible with the plugs on the audiovisual projector equipment being used, and adapters and extension cords secured as required.

d) Room size should be adequate for seating 18 students, plus providing for instructor equipment, projection equipment, and a modest number (4 to 8) of intermittent visitors to the classroom.

e) The classroom should be capable of being darkened quickly and effectively for use of projection equipment or television. Room dimmer lights for indirect lighting (not striking the screen directly) are recommended in fixed training installations, but can be dispensed within a field training situation.

2) Student Facilities

a) Ideally, students should be seated at tables, with all seats facing the instructor's area at the front of the classroom. Each student should be allocated 30" or more of table width. The sidearm chairs so familiar in the classrooms of secondary schools and colleges may be used if absolutely necessary, but are distinctly inferior to tables for student work.

b) Student seating should be at least two screen widths from the projection screen (assuming a 6' screen, no student closer than 12' from the screen) and not more than 6 screen widths from the screen (again assuming a 6' screen, no student more than 36' from the screen). Furthermore, all students should be seated seated within a 30° angle to the left and to the right of a line from the middle of the projection screen to the projector.

3) Classroom Instructional Facilities

   a) Lectern, either freestanding or table-type; suitable for standing instructor

   b) Demonstration table at front of classroom, approximately 3' x 5'

   c) Chalkboard, at least 3' x 5' (preferably larger), with chalk, erasers, pointer

   d) Audiovisual equipment

      (1) Public address system (optional but recommended) with lavalier microphone with adequate cord length to permit instructor to move about at front of classroom with relative freedom

      (2) Projection screen (for size consideration see 2) b above), matte, beaded, or lenticular surface

      (3) Projector, 35-mm slide projector for slides mounted in cardboard or plastic mount; carousel type preferred. Should have projection lens with cord length suitable for use from rear of room

      (4) Projector, overhead type, for use with projectuals approximately 7" x 9"

      (5) Cassette type playback unit, with cueing feature for automatic operation of cassette type slide projector; compatible with National Training and Operational Technology Center (EPA) tape/slide instructional units

      (6) Television tape playback unit (3/4" cassette type, "U-Matic" or equivalent)

      (7) Television receiver, commercial type, color, 19" diagonal picture, or larger At least one receiver, preferably two

c. Laboratory

   1) General Features

      a) Should be well-lighted, adequately ventilated. It is particularly important that the laboratory be free from strong drafts in student working areas.

      b) Should provide for students to stand at laboratory benches which are approximately 36" from floor to bench surface.

      c) Conventional laboratory services should be available at student work areas, including electricity (115 V), gas, and vacuum.

d) Space between benches should be adequate for students to work without interfering with each other, and to permit free movement of instructors in the student working area.

e) Safety features of the laboratory should be checked, including location and condition of first aid kits, fire extinguishers, emergency showers, eye-wash facilities, and other emergency equipment.

2) Student Facilities

a) Provide at least 5' of bench width per student pair. While students will work in pairs to the extent that they will share certain limited equipment, each student will perform all tests and measurements.

b) Provide bench space or floor space as necessary for laboratory equipment described in the equipment and supply lists, such as balances, ovens, waterbaths and other items not assigned to individual student work.

3) Laboratory Instructional Facilities

a) A chalkboard and demonstration table are recommended.

b) Provide at least 20 square feet for reserve supplies and equipment of each instructor.

c) For field courses, provide area for packing and unpacking; areas for equipment to be shipped. This should be at least 100 square feet of floor space, with at least 20 square feet of table space.

d. Security

Valuable property is used both in the classroom and in the laboratory. Some of the items are particularly susceptible to theft. Accordingly:

1) Provide for locking of both classroom and laboratory when not in use, or assure that adequate security is provided in the facility by other means.

2) Be sure that the necessary keys are available to the instructional staff at their need.

3) With field courses, often it is necessary for the training staff to work in the evening or weekends to prepare for coming classwork. Arrangements must be made well in advance to secure authorized entry to the training facilities being made available by a host organization.

4) Thefts during normal working hours may be a special problem. Maintain surveillance to the extent practical, and keep out-of-service theft-prone items out of exposed locations.

3. Laboratory Equipment and Supply Requirements

The consolidated list in this section is for overall planning purposes. For day-to-day laboratory requirements, see the "Equipment and Supply" requirements in each Instructional Package Worksheet (IPW) contained in Part II of this Staff Guide.

The equipment list is in three sections, each related to the requirements of one of the areas of instruction (chemistry, microbiology, engineering). In most cases, individual items of equipment or supply are not subject to shared use in two or more areas of instruction. In the few cases where this does occur, and the item is to be used for more than one purpose, this is indicated in the "remarks" column. Each of the sections, in turn, is divided into three subsections: capital equipment representing more than $100 unit purchase cost, reusable equipment of less than $100 original purchase cost, and consumable equipment having less than $100 original cost. (These prices can be taken only as approximations). Items in the list are described in the language and specifications required for ordering the item from commercial catalogs. The second column lists the minimum quantity per student required for each procedure as taught in the course. The third column lists the minimum quantity for a class of 18 students. The fourth and final column contains remarks that may be useful when deciding on class needs or when ordering equipment and supplies. Many Instructors plan for an additional margin of at least 10% of extra supplies to provide for student errors, planning miscalculations, or other unforeseen events.

Before using the list in this section, the decisions must be made about the specific procedure to be taught for each test in the course. The list presented here covers procedures in outlines 1 - 25 of this Staff Guide. If the instructional staff elects to use procedures described in outlines 26 - 30, it will be necessary to make adjustments in this consolidated list. As stated above, in the final analysis it is necessary to consult the IPWs related to the procedures being used in the course.

A list of this type can be of great value in pre-course planning, to determine the availability of needed equipment and supplies, and to take action to provide needed resources. Further, this list can be of vital importance when planning for courses to be conducted in field locations. Copies of the list in the hands of the Course Coordinator, and a representative of the host organization, can be used to determine which will provide needed resources on an item-by-item basis. When the responsibility is assigned and accepted, this can be annotated in the "remarks" column, with a copy of the annotated list in the hands of the Course Coordinator, and a copy for the representative of the host organization. Each can then use the annotated equipment and supply list as a checklist for carrying out his own agreed-upon responsibilities in preparing for the course.

I. BACTERIOLOGY LABORATORY EQUIPMENT AND SUPPLIES REQUIREMENTS

A. CAPITAL EQUIPMENT (More Than $100 Unit Value)

	Quantity for --		
DESCRIPTION	MPN	MF	REMARKS
Autoclave, providing uniform temperatures up to and including 121°C, equipped with an accurate thermometer, pressure gauges, saturated steam power lines and capable of reaching desired temperature in 30 minutes.	1	1	
Balance, 0.1 g sensitivity at a load of 150 g	4 - 6	4 - 6	
Funnel Unit, membrane, unit assembly, sterile, equipped with No. 8 rubber stopper to fill 1-liter vacuum flask.	-	9	
Incubator with saturated relative humidity, adjusted to 35 ± 0.5°C and to accommodate a minimum of 18 culture tube racks (approximately 6" X 12" each).	1	-	
Incubator, waterbath, adjusted to 44.5 ± 0.2°C and to accommodate 5 to 10 tube racks (approximately 6" X 12" each).	1	1	
Microscopes, stereoscopic, magn. 10X or 15X binocular type preferred.	-	1	

	Quantity for --		
DESCRIPTION	MPN	MF	REMARKS
Oven, hot-air sterilizing, to give uniform temperatures and with suitable thermometers to register accurately in range of 160-180°C	1	1	
pH meter, electrometric, accurate to at least 0.1 pH unit	1	1	
Refrigerator: Operates at 6°-10°C	1	1	Temporary sample storage, storage of MF media, reagents. Not for storage of MPN media.
UV light to resterilize funnels if necessary	-	-	Optional
Vacuum Service: preferably a central service. An electric vacuum pump assembly with suitable hoses, water traps, and shut-off valves is acceptable. As a last resort, but not recommended, use a water aspirator or hand-pump.	-	X	Service to 9 lab work positions.

B. REUSABLE SUPPLIES and Durable Property of Less than $100 Unit Value

DESCRIPTION	MPN	MF	REMARKS
Aprons, laboratory (plastic acceptable)	18	18	
Baskets for discarded cultures	9	9	
Beakers, 400-600 ml	9	9	
Bottles, dilution, 6 oz., preferably borosilicate glass, with screw cap (or rubber stopper protected by paper) with 99 ml volume etched on side.	48	72-144	
Bottle, mixing, 4 liter, wide-mouth, borosilicate glass	2	3	
Bottles, sample, 250-ml wide mouth, glass stopper	10	20	
Bottles, squeeze, for disinfecting solution	9	9	

DESCRIPTION	MPN	MF	REMARKS
Bottles, wide-mouth (for about 20 ml methanol to sterilize forceps)	-	9	
Burners, gas	9	-	
Cans, pipet, aluminum or steel, not copper. (If plastic, disposable pipets are used, this item is not necessary.)	18	18	Not necessary if single-service glass or plastic, pre-sterilized, wrapped pipets are used.
Caps to fit 20 X 150 mm culture tubes	800	-	
Clamps, pinchcock, strong enough for tight compression of vacuum tubing	9	9	
Cylinders, 100 ml graduated, sterile	-	9	
Filters, membrane, white, grid marked, sterile pore size suitable for bacterial retention, (usually about 0.45μ) in units of 10 filters per package	-	200	20 packages of 10 filters/package
Flasks, Erlenmeyer type, 250 ml; borosilicate glass.	-	9	

DESCRIPTION	MPN	MF	REMARKS
Flasks, suction, glass, 1 liter, mouth to fit No. 8 stopper	-	9	
Forceps, curved-end round tipped, for MF work	-	18	
Funnels, glass, 4-6" diameter. Borosilicate	9	-	
Hot plates, electric, thermoregulator	-	9	Alternately, use tripod with gas burner.
Jars to receive used pipets.	9	9	
Lamp, fluorescent, for dissecting microscope	-	9	
Loops, inoculation, 3 mm diameter loop of nichrome or platinum - iridium wire, 26 B&S gauge, in suitable holder	18	-	
Pads, absorbent (for nutrient), 47 mm in diameter, sterile, in units of 10 pads per package	-	200	Usually supplied with the membrane filters.

DESCRIPTION	MPN	MF	REMARKS
Pipets, 1 ml with 0.1 ml graduations, Mohr type preferred, sterile, cotton plugged, glass or disposable plastic. Quantity given is minimum number required. Each pair of students should be given a can with 10-12 glass pipets or else a package of a dozen plastic pipets.	48	18	
Pipets, 10 ml graduated, Mohr type preferred, sterile, cotton plugged, glass or disposable plastic. Again this is a minimal quantity. Each student pair should be given a can with glass pipets or else a surplus of the individually packed plastic pipets.	18	72-80	
Racks, culture tube, 10 X 5 openings to accept tubes of 25 mm diameter, minimum	24	18	
Ring stand; to accommodate 4 - 6" glass funnels	9	-	
Sponges for cleaning desk tops	9	9	

DESCRIPTION	MPN	MF	REMARKS
Tallies, hand, single unit acceptable, hand or desk type	-	9	
Thermometer (for use in incubator water bath). Must indicate in the 40°-50°C range and have increments of 0.1°C. Should be NBS certified or calibrated against NBS certified thermometer. Full Immersion type preferred.	1	1	
Thermometer (for use in sterilizing oven). Must indicate within the 160 - 180°C range and should have increments at least 1.0°C.	1	1	
Thermometer (for use in 35°C incubator). Must indicate in the 30-40°C range and have increments of at least 1.0°C. Should be NBS certified thermometer. Best used with bulb immersed in water, glycerine, or oil fitted in flask or bottle with rubber stopper.	1	-	
Tongs, crucible (to fit culture tubes)	-	9	
Tubes, fermentation, 12 X 75 mm vials to be inverted in culture tubes	800	-	

DESCRIPTION	MPN	MF	REMARKS
Tubes, culture, 20 X 150 mm	660	-	
Tubing, rubber, 2-3 foot lengths, latex rubber, 3/16" I. D. by 3/32" wall (for vacuum flask).	-	9	

C. CONSUMABLE RESOURCE SUPPLIES

These items will either (1) be used directly by the student, (2) be used by staff in preparing solutions and media described in following section.

DESCRIPTION	MPN	MF	REMARKS
Bags, waterproof plastic, 3 X 7-1/4" for culture dish incubation	-	36	
EC Broth, dehydrated; Difco, BBL, or equivalent, in 1/4-lb. bottles.	4-6	-	Do not buy 1-lb bottles.
Dishes, Petri, 50 X 12 mm, sterile, plastic or glass.	-	120	Most workers use plastic Petri dishes.
Iodine, crystals, 1/4-lb. bottle	1	1	For preparation of disinfectant solution
Lactose Lauryl Sulfate Tryptose Broth; BBL, Difco, or equivalent. Dehydrated. 1-lb. bottle.	1	-	
M-FC Broth, Dehydrated; BBL, Difco, or equivalent. 1/4-lb. bottles.	-	4-6	Do not buy 1-lb. bottles.
Methanol (for sterilizing forceps), 20 ml amounts in 12 wide mouth bottles	-	9	

DESCRIPTION	MPN	MF	REMARKS
Potassium dihydrogen phosphate (KH_2PO_4) 1/4-lb. bottle	1	1	For preparation of dilution water
Potassium Iodide (KI), crystals, 1/4-lb. bottles	1	1	For preparation of disinfectant solution
Pencils, china-marking, wax	18	18	
Rosolic Acid, powdered, 1-gram units	-	1	
Sodium Hydroxide (NaOH) pellets, 1/4-lb. bottle	1	1	
Water, distilled or deionized. Suitable for use in bacteriological culture media.	20	30	Many laboratories will have their own distillation apparatus; others must use commercial sources.

D. CONSUMABLE RESOURCE SUPPLIES (requiring staff preparation)

These items will require preparation by staff, in advance of the course. Materials for preparation and containment of these items should, without exception, be listed in foregoing lists of equipment and supplies.

DESCRIPTION	MPN	MF	REMARKS
Dilution water, sterile, 99-ml blanks, in 6-oz. screwcapped bottles, with mark at 99-ml mark	48	72-144	
Dilution Water: for class samples.	2	2	Prepare 3 liters of sterile dilution water in 4-liter glass bottles. On appropriate class day(s) deliver appropriate amount of fresh domestic sewage to the dilution water. See special instructor's notes for the lessons.
Iodine-Potassium Iodide Solution, consisting of 3 grams Iodine crystals, 6 grams Potassium Iodide crystals, dissolved in 3 liters distilled water, and dispensed in plastic squeeze bottles.	1	1	

DESCRIPTION	MPN	MF	REMARKS
Lactose Lauryl Sulfate Tryptose Broth, 10-ml portions of single-strength medium, 10 ml portions in 20 X 150 mm culture tubes with fermentation vials, metal caps. Sterile	400	-	
Sodium Hydroxide solution, 0.2 N	-	200 ml	For preparing 1% Rosolic Acid solution
Sodium Hydroxide Solution, 1 N	1 liter	1 liter	For preparing stock solution phosphate buffer for dilution water.

II CHEMISTRY LABORATORY EQUIPMENT AND SUPPLY REQUIREMENTS

Key to Abbreviations for Tests:

BOD - Biochemical Oxygen Demand
DO(W) - Dissolved Oxygen, Winkler
DO(P) - Dissolved Oxygen, Probe
Cl - Chlorine Residual
pH - pH
SS - Suspended Solids

A. CAPITAL EQUIPMENT (More Than $100 Unit Value)

DESCRIPTION	QUANTITY FOR: EACH TEST	CLASS OF 18	REMARKS
Amperometric Titration Assemblies including sample cups and measuring pipets, 1 and 5 ml	Cl 1	9	A written EMP based on Wallace and Tiernan* equipment is available. It could be adapted for other amperometric titration assemblies
Balances, analytical, 0.1 mg sensitivity at a load of 200 g. (with Instruction manuals)	SS 1	3	Also for advance preparation of reagents
Balance, trip, 500 gram capacity	BOD 1 DO(W) 1	1	For advance preparation of reagents
Dissolved Oxygen Meters with probes and probe agitator assemblies, and accessory kits which include membranes	DO 1	9	Written EMPs based on the Weston and Stack* Model 300 and also on the Yellow Springs Instrument* Model 54 are available. Either could be adapted for other oxygen meters.
Distilling apparatus, water still, all-glass or block tin	BOD 1	1	Also can be used to prepare distilled water for the other lab procedures.
Electrical outlets, 115 volt, single phase, 60 cycle ac power	Cl 1	9	

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
Hot plate, magnetic stirrer, platform area about 5 1/2" by 7", with magnet	BOD 1 DO(W) 1 Cl 1	1	For advance preparation of reagents
Incubator or constant temperature bath capable of maintaining 20° ± 1°C, and large enough to contain 36 BOD bottles and 2 ten liter bottles	BOD 1	1	
Oven, hot air, to give uniform temperatures and with thermometer to register accurately in range of 103 - 105°C. Capacity for 18 - 90 mm dia. watch glasses plus 18 - 25 ml Gooch crucibles	SS 1	1	See Microbiology, Capital Equipment
pH meters, electrometric, accurate to at least 0.1 pH unit	pH 1	9	A written EMP based on the battery - operated Instrumentation Laboratory* Model 175 is available. It could be adapted for other pH meters.
Refrigerator large enough to store up to 7 one liter reagent bottles	BOD 1 DO(W) 1	1	To store reagents prepared in advance
Sinks for glassware clean-up and discard solutions.	All 1	3	
Vacuum Sources: preferably a central service. An electric vacuum pump assembly with suitable hoses, water traps and shut off valves capable of drawing 15 inches mercury is acceptable.	SS 1	18	Unlisted quantities of tubing and connectors may be required. See Microbiology, Capital Equipment

* Mention of a specific brand name does not constitute endorsement of the U.S. Environmental Protection Agency.

B. REUSABLE EQUIPMENT (Less Than $100 Unit Value)

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
Aprons, laboratory (plastic acceptable)	All 1	18	
Beakers, glass, 25 ml	DO(W) 1 pH 1	18	
Beakers, glass, 50 ml	Cl 1	9	
Beakers, graduated, glass, 150 ml	pH 5	45	
Beakers, glass 250 ml	DO(P) 1	9	Weston and Stack* Meter 300
Bottle, amber glass, 1 liter, with screw cap	Cl 1	1	Omit if PAO solution is purchased
Bottles, glass, ~30 ml, with 1 ml dropper pipet in screw cap	Cl 3	27	Omit if solutions are purchased in dropper bottles
Bottles, glass, BOD, 300 ml glass stoppers	BOD 4 DO(W) 1 DO(P) 4	153	Total quantity based on all three lab sessions on same day, precluding multiple use of bottles
Bottles, glass, reagent, 250 ml, with glass stoppers for all but one which requires a rubber stopper.	BOD 4 DO(W) 6	10	
Bottle, glass, reagent, 2 liter with glass stopper	DO(W) 1	1	To contain standardized sodium thiosulfate sol.

DESCRIPTION	QUANTITY FOR: EACH TEST	 CLASS OF 18	REMARKS
Bottles, glass, small neck solution carboys, 10 liter	BOD 2	2	
Bottles, polyethylene, aspirator with spigot, 5 gallon, screwcap, to dispense distilled water	All 2	2	Can be used with siphons for water samples required for DO(W) and DO(P)
Bottles, polyethylene, squeeze, each with delivery tip, about 2 oz.	pH 1	9	To contain sat. KCl sol.
Bottles, polyethylene, ~60 ml, screw caps	DO(P) 2	18	Weston and Stack* Meter 300 To contain electrolyte and Na OH sols.
Bottles, polyethylene preferred or pyrex, ~180 ml, screw caps	pH 2	18	To contain buffers
Bottles, polyethylene, resistant to adsorption of solids, 500 ml, screw caps	Cl 1 pH 3 SS 2	27	To contain student portions of samples. Attach sample tags.
Bottle, polyethylene, resistant to adsorption of solids, 2 liter, screw cap	BOD 1 SS 1	1	To collect sample. Attach sample tags.
Bottle, polyethylene, resistant to adsorption of solids, 4 liter, screw cap	Cl 1 SS 1	1	To collect sample. Attach sample tags.
Bottle, polyethylene, resistant to adsorption of solids, 8 liter, screw cap	BOD 1	1	To collect secondary treatment effluent sample. Attach sample tag.

DESCRIPTION	QUANTITY FOR: EACH TEST	CLASS OF 18	REMARKS
Brushes, assorted for cleaning glassware	At Sinks	9	
Brushes, balance	SS 1	3	
Bulbs, pipet, large	BOD 1 DO(W) 1	9	
Burets, 25 ml, 0.1 ml graduations, teflon stopcock plug preferred	DO(W) 1	18	
Clamps, buret, for titration stand	DO(W) 1	18	
Clamps, pinchcock, strong enough for tight compression of vacuum tubing	BOD 1 SS 1	20	See Microbiology, Reusable Equipment
Cork borers, set	SS 1	1	To make hole in No. 8 rubber stoppers for funnel filter holders prior to student lab session.
Crucibles, Gooch, porcelain 25 ml capacity	SS 1	36	18 are used to prepare filter discs prior to student lab session.
Crucible holders, Walter, for 25 ml porcelain Gooch crucibles to fit 1 liter filter flask	SS 1	18	
Cylinders, graduated, 25 or 50 ml	SS 1	18	

	QUANTITY FOR:		
DESCRIPTION	EACH TEST	CLASS OF 18	REMARKS
Cylinders, graduated, 100 ml	BOD 1 SS 2	36	Required for BOD if sample is primary treatment effluent
Cylinders, graduated, 250 ml	BOD 1	18	Required if sample is secondary treatment effluent
Cylinders, graduated, 1 liter	BOD 2	36	
Desiccators with effective desiccant and to accomodate 18 - 90 mm dia. watch glasses plus 18 - 25 ml Gooch crucibles.	SS x	x	x - number of desiccators needed depends on their size
Flask, Erlenmeyer, wide mouth, 250 ml	DO(W) 1 DO(P) 1 pH 1	1	For advance preparation of reagents. See Microbiology, Reusable Equipment
Flasks, Erlenmeyer, wide mouth, 500 ml	DO(W) 1	18	
Flasks, filtering (suction), heavy glass wall with side tube for hose connection and mouth to fit No. 8 stopper, 1000 ml.	SS 1	18	See Microbiology, Reusable Equipment
Flask, volumetric, 100 ml, with glass stopper	BOD 1	1	For advance preparation of reagents
Flask, volumetric, 250 ml, with glass stopper	Cl 1 DO(W) 1 DO(P) 1	1	For advance preparation of reagents

DESCRIPTION	QUANTITY FOR: EACH TEST	QUANTITY FOR: CLASS OF 18	REMARKS
Flask, volumetric, 1 liter with glass stopper	Cl 1 pH 1	1	For advance preparation of buffers and sample
Flask, volumetric, 2 liter with glass stopper	DO(W) 1	1	For advance preparation of std. thiosulfate sol.
Forceps, cover glass, curved ends	SS 1	18	
Funnels, short stem, diam. about 75mm (to fill 25ml buret)	DO(W) 1	18	
Funnel filter holders: membrane unit assemblies or porcelain Buchner funnels or porcelain Hirsch funnels, requiring a disc about 5 cm dia. for filtering influent samples.	SS 1	18	Can use some of each type See Microbiology, Capital Equipment
Glasses, safety	DO(W)1pr	9pr	
Knives, small pocket	DO(P) 1	9	Weston and Stack* Meter 300 .
Mixing rods, plunger-type, 18 inch minimum length	BOD 1	18	
Mortar and pestle, glass or porcelain, with spout, 8 oz.	DO(W) 1	1	For advance preparation of starch sol.
Pipets, dropping (medicine droppers), with bulb, about 1 ml volume	DO(W) 1	18	

DESCRIPTION	QUANTITY FOR: EACH TEST	QUANTITY FOR: CLASS OF 18	REMARKS
Pipets, measuring, Mohr, glass, 5 ml graduated in 1/10	DO(W) 3	3	
Pipets, volumetric transfer, one ml	BOD 4	4	For stock bottles of nutrients
Pipets, volumetric transfer, twenty ml	BOD 1	18	Required if sample is primary treatment effluent
Pipet, volumetric tansfer, 100 ml	DO(W) 1	1	For advance preparation of std. thiosulfate sol.
Scissors, small-size pairs	DO(P) 1	9	Yellow Springs Instrument* Meter 54
Screwdrivers, small blade	DO(P) 1	9	Weston & Stack * Meter 300
Siphons, glass, about 18 inches long, with soft rubber tubing attached for delivery control.	BOD 1	18	
Siphons, glass,long enough to reach to the bottom of a 10 liter bottle, with soft rubber tubing attached for delivery control	BOD 1	2	
Spatula, medium size	All 1	1	For advance preparation of reagents
Sponges for cleaning bench top	All 1	9	See Microbiology, Reusable Equipment

DESCRIPTION	QUANTITY FOR: EACH TEST	CLASS OF 18	REMARKS
Stands, titration, support for buret	DO(W) 1	18	
Stoppers, rubber, size 8, with hole for funnel filter holder	SS 1	18	Size of hole depends on type of funnel filter holder used
Syringes, 5 cc or (medicine) dropper pipets	DO(P) 1	9	
Tongs, crucible	SS 1	18	See Microbiology, Reusable Equipment
Tubing, rubber 2-3 foot lengths, 3/16" I.D. by 3/32" wall for vacuum flasks	SS 1	18	See Microbiology, Reusable Equipment
Wash bottles, squeeze type 500 ml	All 1	9	
Watch glasses, 90 mm dia., for filter disc supports	SS 1	36	18 are used to prepare filter discs prior to student lab session

* Mention of a specific brand name does not constitute endorsement of the U.S. Environmental Protection Agency

C. CONSUMABLE SUPPLIES

	QUANTITY FOR:		
DESCRIPTION	EACH TEST	CLASS OF 18	REMARKS
Cotton, small wads to fit neck of 10 liter bottles	BOD 1	2	
Detergent, in small boxes or jars at sinks	All 1	3	
Filter discs, glass fiber without organic binder, Reeve Angel 934H or 984H, Gelman Type A, Whatman GF/C or equivalent, Size should cover holes in funnel filter holders to be used (∿ 5 cm. dia.) and also to fit 25 ml Gooch crucibles (∿ 2.1 cm. dia.)	SS 2 ea. size	72	18 of ea. size should be prepared (rinsed-dried) prior to student lab session
Lubricant, silicone (stopcock) small tubes	DO(P) 1 Cl 1	9	Weston and Stack * Meter 300
Marking ink supply or tool to permanently mark glass and porcelain.	SS 1	1	To make identification marks on Gooch crucibles prior to student lab session
Notebooks, to record data	BOD 1 DO(W) 1 DO(P) 1	18	
Pens, felt tip, to mark beakers, watch glasses, etc.	pH 1 SS 1	9	
Pencils, wax marking	BOD 1 DO(P) 1	9	
Reagents are listed according to test at the end of this section.			

DESCRIPTION	QUANTITY FOR: EACH TEST	QUANTITY FOR: CLASS OF 18	REMARKS
Required samples are listed according to test at the end of this section			
Rubber bands, large	DO(P) 2	36	Weston and Stack* Meter 300
Sample tags, preferably pre-printed, with blanks for information required by NPDES reports.	BOD 1 DO(W) 1 DO(P) 1 Cl 10 pH 27 SS 20	60	For bottles containing sample.
Tape, transparent, rolls	DO(P) 1	9	
Tissues, soft, in boxes, for handling Gooch crucibles	SS 1	9	
Towels, paper in boxes or packets at sinks	All 1	3	
Water, distilled from all glass or block tin distilling apparatus	BOD 2 ℓ	40 ℓ	Quantity includes water used for reagent preparation.
Water, distilled, from central supply or can be purchased	DO(W)8 ℓ DO(P)13 ℓ Cl 1 ℓ pH 14 ℓ SS 2 ℓ	38 ℓ	Amounts represent water used for reagent and sample preparations, as well as student lab sessions.

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
weighing boats, disposable	BOD 4 DO(W) 6 DO(P) 3 Cl 11 pH 5	29	For advance preparation of reagents
Reagents, BOD Test:			For preparations according to 1971 Standard Methods, 13th ed., p.489 ALL reagents should be prepared PRIOR to student lab sessions.
Calcium chloride solution:			
27.5 g/l anhydrous calcium chloride	BOD 2ml	100 ml	
Ferric chloride solution:			
0.25 g/l ferric chloride hexahydrate	BOD 2ml	100 ml	
Magnesium sulfate solution:			
22.5 g/l magnesium sulfate heptahydrate	BOD 2ml	100 ml	

DESCRIPTION	QUANTITY FOR: EACH TEST	QUANTITY FOR: CLASS OF 18	REMARKS
Phosphate Buffer Solution:			KH_2PO_4 also used for Cl and pH
8.5 g/l potassium dihydrogen phosphate,			
21.75 g/l dispotassium hydrogen phosphate,			
33.4 g/l disodium hydrogen phosphate heptahydrate,	BOD 2ml	100 ml	
1.7 g/l ammonium chloride			
Reagents for 72 Winkler Determinations unless a dissolved oxygen meter is to be used.			See Reagents, Dissolved Oxygen, Winkler Method.
Reagents, Dissolved Oxygen, Winkler Method:			For preparations according to 1971 EPA Manual, p. 53 ALL reagents should be prepared PRIOR to student lab sessions.
Alkali-iodide-azide solution:			NaOH also used for DO(P) and Cl
500 g/l sodium hydroxide	BOD 8ml		
135 g/l sodium iodide	DO(W)2ml	250 ml	
10 g/l sodium azide	DO(P)2ml		

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
Chloroform	BOD 15ml DO(W)15ml DO(P)15ml	15 ml	To preserve starch and thiosulfate sols. Also used for Cl
Manganous sulfate solution: 480 g/l manganous sulfate tetrahydrate	BOD 8ml DO(W)2ml DO(P)2ml	250 ml	
Potassium biiodate solution: 4.873 g/l potassium biiodate	BOD 250ml DO(W)250ml DO(P)250ml	250 ml	25.0 ml is diluted to 100 ml. of which 40.0 ml is used for duplicates to standardize thiosulfate sol.
Potassium iodide crystals	BOD 6g DO(W)6g DO(P)6g	6 g	To standardize thiosulfate sol., also used for DO(P) and Cl
Sodium thiosulfate stock solution: 186.1 g/ℓ sodium thiosulfate pentahydrate	BOD 50 ml DO(W)50 ml DO(P)50 ml	250 ml	100.0 ml is diluted to 2 ℓ. std. sol.. 648 ml may be needed for BOD, 162 ml each for DO(W) and DO(P). Additional volume is for buret rinses.
Starch solution: 10 g/l soluble starch	BOD 8ml DO(W)2ml DO(P)2ml	250 ml	Also used for Cl

DESCRIPTION	QUANTITY FOR: EACH TEST	CLASS OF 18	REMARKS
Sulfuric acid, concentrated	BOD 8ml DO(W)2ml DO(P)2ml	250 ml	
Reagents, Dissolved Oxygen, Probe Method:			For preparations according to Instruction Manuals for Weston and Stack* Model 300 or Yellow Springs Instrument* Model 54 ALL reagents should be prepared PRIOR to student lab sessions.
Electrolyte solution: 50 g/100 ml potassium iodide, 0.1 g/100 ml sodium sulfite	DO(P)~15ml	250 ml	Weston and Stack* Meter 300; sol. can be purchased from Weston and Stack*. KI also used for DO(W) and Cl.
Electrolyte solution: 1:1 distilled water/sat. potassium chloride sol. (56.7g/100ml at 100°C)	DO(P)~15ml	250 ml	Yellow Springs Instrument* Meter 54; sol. can be purchased from YSI. sat. KCl sol. also used for pH
Sodium hydroxide solution: 10 g/90 ml sodium hydroxide	DO(P)~15ml	250 ml	Weston and Stack* Meter 300 NaOH also used for DO(W) and Cl

	QUANTITY FOR:		
DESCRIPTION	EACH TEST	CLASS OF 18	REMARKS
Sodium sulfite solution: about 2g/500 ml	DO(P)∿1g	18g	Weston and Stack* Meter 300 Also used in DO(P) electrolyte sol.
Reagents for 18 Winkler DO Determinations			See Reagents, Dissolved Oxygen, Winkler Method
Reagents, Chlorine Residual:			For prepartions according to 1972 ASTM Part 23, p. 223 ALL reagents should be prepared PRIOR to student lab sessions
Buffer solution, pH4.0: 243 g/ℓ sodium acetate trihydrate 480 g/ℓ glacial acetic acid	Cl 1ml	250ml	Sol. can be purchased from Wallace and Tiernan*
Buffer solution, pH7.0: 25.4g/ℓ potassium dihydrogen phosphate 86 g/ℓ disodium hydrogen phosphate with 12 molecules of water of hydration	Cl 1ml	250ml	Sol. can be purchased from Wallace and Tiernan* KH_2PO_4 also used for BOD and pH

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
Potassium iodide solution: 50 g/ℓ potassium iodide	Cl 1ml	250 ml	Sol. can be purchased from Wallace and Tiernan*. KI also used for DO(W) and DO(P)
Sodium chloride, U.S.P.	Cl~20g	360 g.	Pellets can be purchase from Wallace and Tiernan*.
Phenylarseneoxide solution, 0.00564 N: 0.8 g/ℓ phenylarseneoxide 1.8 g/ℓ sodium hydroxide (Adjust pH with 1+1 hydrochloric acid) Standardize with 0.0282N iodine solution: 25 g/ℓ potassium iodide 4.946 g/ℓ arsenous oxide hydrochloric acid 1 ml chloroform 12.7 g/ℓ iodine crystals 5g/500ml sodium hydroxide 1g/100ml starch sol.	Cl~10ml	1 ℓ.	Sol. can be purchased from Wallace and Tiernan*. NaOH and KI are also used for DO(W) and DO(P). chloroform and starch are also used for DO(W).

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
Reagents, pH			For preparations according to 1971 Standard Methods, 13th ed. p.278 ALL reagents should be prepared PRIOR to student lab session.
Buffer solution, pH 6.9: 3.388g/liter potassium dihydrogen phosphate, 3.533 g/liter disodium hydrogen phosphate, carbon dioxide-free water	pH 125ml	3ℓ	Pre-weighed buffer chemicals can be purchased. KH_2PO_4 is also used for Cl and BOD
Buffer solution, pH 7.4: 1.179 g/ℓ potassium dihydrogen phosphate, 4.302 g/ℓ disodium hydrogen phosphate, carbon dioxide - free water	pH 125ml	3ℓ	Pre-weighed buffer chemicals can be purchased. KH_2PO_4 is also used for Cl and BOD
Electrolyte solution: 56.7 g/100ml potassium chloride, at 100°C for saturated solution. Add silver chloride in dissolvable amt.	pH∿10ml	250ml	Electrolyte sol. can be purchased from manufacturers of pH meters, KCl also used for DO(P)

DESCRIPTION	QUANTITY FOR:		REMARKS
	EACH TEST	CLASS OF 18	
Sample, Biochemical Oxygen Demand: non-Chlorinated treatment plant effluent	BOD 80ml or 400ml	2ℓ or 8ℓ	Collect just before student lab session. 2 liters of primary treatment effluent or 8 liters of secondary treatment effluent
Sample, Dissolved Oxygen, Winkler Method: Water containing dissolved oxygen	DO(W)300ml	6ℓ	Prepare by agitation, then quiescence prior to student lab session.
Sample, Dissolved Oxygen, Probe Method: Water containing dissolved oxygen	DO(P)300ml	6ℓ	Prepare by agitation, then quiescence prior to student lab session.
Sample, chlorine: Chlorinated treatment plant effluent	Cl 200ml	4ℓ	Collect just before student lab session. Quantity is for Wallace and Tiernan* Assembly.
Sample, pH: Three samples with different pH values	pH ea. 125ml	pH ea. 3ℓ	Prepare prior to student lab session.

DESCRIPTION	QUANTITY FOR: EACH TEST	CLASS OF 18	REMARKS
Sample, suspended solids: Treatment plant influent or an equivalent mixture	SS∿ 100ml	2ℓ	Can be collected 1 or 2 days before student lab session.
Sample, suspended solids: Treatment plant effluent or an equivalent mixture	SS∿ 200ml	4ℓ	Can be collected 1 or 2 days before student lab session.

* Mention of a specific brand name does not constitute endorsement of the U. S. Environmental Protection Agency.

III ENGINEERING - Sampling

A. CAPITAL EQUIPMENT (More Than $100 Unit Value)

	QUANTITY FOR:	
DESCRIPTION	CLASS OF 18	REMARKS
Sampler, APHA type, as described in Standard Methods, 13th ed., p.476	1	For demonstration
Sampler, Kemmerer type, as described in Standard Methods, 13th ed., p. 728	1	For demonstration
B. REUSABLE EQUIPMENT (Less Than $100 Unit Value)		
Float gage	1	For demonstration Optional - used if available
Parshall Flume with stilling well and connection to flume	1-3	To illustrate flume Configuration. Models could be used in classroom.
Staff gage section, standard 3.33 foot section	1	To illustrate gage
Wier plate(s)	1-3	To illustrate wier configuration. 90° and/or 60° and/or end contractions, etc..

The following effluent monitoring procedures were added to the Student Reference Manual. Equipment required for these procedures is not included in this compiled list.

1. Dechlorination of Samples for Biochemical Oxygen Demand and Seeding of the Dilution Water
2. Determination of Dissolved Oxygen in Wastewater: Polarographic Probe Method
3. Settleable Solids, mg/liter (Imhoff Settling Cone)

2. Instructional Resources

a. Introduction

Most training institutions will make the fullest possible use of pre-existing instructional resources. The purpose of this section is to describe the nature, sources, and availability of instructional resources suggested for use with this course.

1) The Instructional Package Worksheets (IPWs) in Part II of this Manual and the student reference text refer to a number of different instructional resources.
These include:

   a) The student reference text itself;

   b) Audiovisual training aids; and

   c) Supportive references

2) Instructional resources are discussed in this section from the viewpoint of the sources of the materials:

   a) Resources developed by United States Environmental Protection Agency (U.S. EPA)

   b) Resources developed by other sources; and,

   c) Resources already in possession of the training institution conducting this course.

b. Instructional Resources Developed by U.S. EPA

1) Student Reference Text and Staff Guide for the course "Effluent Monitoring Procedures Nutrients":

   a) NTIS can supply copies of the Text and Guide. A paper copy of the Text (PB-261-290/AS) costs $9.75. Contact NTIS for the identification number and cost of a paper copy of this Guide.

   A microfiche copy of either the Text or Guide is also available from NTIS at $3.00 each.

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22151

b) NTOTC has negatives of the Text and Guide which are available for temporary loan on request of a sponsoring Agency wishing to duplicate the materials.

c) Your state agency may be able to arrange a direct supply of the texts and/or guides. Before ordering/reproducing materials, you might consult with your state agency about this possibility.

2) Audiovisual Training Aids developed for the Course:

a) What is available, according to topic:

(1) Five-Day Biochemical Oxygen Demand (BOD-5).

(a) XT-54, Slide/Tape Unit, "Determination of BOD," 13 minutes, 71 slides.

(b) TC-40, Videocassette Tape Unit, "Determination of 5-Day BOD: Sample Dilution", 23 minutes

(c) OT-2, Overhead Transparencies -14.

(2) Determination of Dissolved Oxygen

(a) Azide Modification

1 XT-29, Slide/Tape Unit, "Dissolved Oxygen Determination", 15 minutes, 72 slides

2 TC-38, Videocassette Tape Unit, "Dissolved Oxygen Determination Winkler/Azide: Titration of Sample", 27 minutes.

3 TC-39, Videocassette Tape Unit, "Dissolved Oxygen Determination Winkler/Azide: Standardization of Sodium Thiosulfate:, 27 minutes.

4 OT-1, Overhead Transparencies - 6.

(b) Using a DO Meter

1 X-6, Slides, unassembled - 28, shows various parts of Weston/Stack DO Meter

2 TC-41, Videocassette Tape Unit, "Determination of Dissolved Oxygen Using a DO Meter", (Weston-Stack); two tapes, Part I, 26 minutes, Part II, 38 minutes.

(c) Polarographic Probe

1 XT-83, Slide/Tape Unit, "Determination of Dissolved Oxygen-Polarographic Probe (YSI)", 6 minutes, 32 slides.

(3) For pH Determination

(a) XT-69, Slide/Tape Unit, "pH Meter-Laboratory Operation", 12 minutes, 49 slides.

(b) OT-11, Overhead Transparencies - 7.

(4) Microbiology

(a) Bacteriological Sampling

1 X-11, Slides, unassembled - 6.

(b) Fecal Coliform Test - Multiple Tube Method

1 OT-3, Overhead Transparencies - 15. Used with lessons 1, 4 and 9.

2 TC-12, Videocassette Tape Unit, "MPN Procedures". Covers: Equipment and Supplies, Data Sheet Preparation, Assembly and Labeling of Culture Tubes and Sample Innoculation. Used with lessons 2, 4, 5 and 6.

3 TC-13, Videocassette Tape Unit, "MPN Procedures", Covers: 24-hour, 48-hour and 72-hour Test Procedures Codifying Results and Use of the MPN Table. Used with lessons 7, 8 and 9.

(c) Fecal Coliform Test - Membrane Filter

1 X-12, Slides, unassembled - 17. Used with lesson 2, "Equipment and Supply Requirements".

2 X-13, Slides, unassembled - 12. Used with lesson 3, "Preparation of Culture Medium".

3 X-14, Slides, unassembled - 15. Used with lesson 5, "Filtration Procedures".

4 X-15, Slides, unassembled - 19. Used with lesson 6, "Colony Counting".

5 OT-13, Overhead Transparencies - 2. Used with lesson 4 and 9.

(d) Calculation of Geometric Mean of Fecal Coliform

1 XT-85, Slide/Tape Unit, "Simplified Geometric Mean", Parts I, II and III, 47 minutes, 87 slides.

For use with persons who can apply the basic skills of addition, subtraction, multiplication and division, but who are not familiar with the use of logarithms.

2 XT-86, Slide/Tape Unit, "Geometric Mean", Parts I, II and III, 35 minutes, 78 slides. For use with persons who can calculate simple averages. Prior ability to use logarithms helpful, but not mandatory.

(5) Sewage Solids

(a) Total Suspended Solids

1 OT-4, Overhead Transparencies - 7. Used with all lessons.

2 TC-21, Videocassette Tape Unit, "Suspended Solids", Part I "Preparing the Filter Disc", 15 minutes. Part II "Procedures", 13 minutes.

(b) Settleable Solids

1 TC-42, Videocassette Tape Unit, "Settleable Solids", 15 minutes

(6) Chlorine

(a) Amperometric Titration

1 XT-37, Slide/Tape Unit, "Residual Chlorine and Chlorine Demand", 12 minutes, 56 slides.

2 OT-5, Overhead Transparencies - 10.

(b) Iodometric Titration

1 XT-93, Slide/Tape Unit, "Determination of Total Residual Chlorine - Iodometric Titration Method", 10 minutes, 42 slides.

(7) Flow Measurement

(a) Parshall Flume

1 OT-6, Overhead Transparencies - 6.

2 X-16, Slides, unassembled - 2.

(b) Sharp-Crested Weir

1 OT-12, Overhead Projectuals - 5.

(8) Report of Self-Monitoring Data

(a) OT-14, Overhead Transparencies - 7.

b) How to request loan of audiovisual training aids:

(1) All items described in b.2)a) above are available on scheduled loan from NTOTC to institutions conducting this course. Requests should contain the information items on the "Request for Loan" form, page 9-9. Send requests to NTOTC at the address given in b.1)a) above.

(2) It is urged that materials desired from NTOTC for a specific course offering be requested in a single, consolidated communication. This will give greatest assurance of a well-coordinated response. Because these requests ordinarily will cover a number of different items, telephonic requests should not be made.

(3) Requests should be timely. To assure effective delivery in time for use in the course, requests should be received at NTOTC at least 45 days prior to the course date. The Center will, in turn, make every effort to assure that the requested materials are delivered to the requesting institution several days prior to the start of the course in which they are to be used. This will permit review and practice by the instructional staff for the most effective use of such resources.

(4) It is expected that all borrowed resources be returned to the Center within two weeks after completion of the course in which they are used.

(5) With returned borrowed training resources, it is requested that the user provide the Center with an evaluation of the training resource(s) used. In this manner the experience of users can be a factor in continuous improvements and responses to problems in using the resources. All reports on use of such resources should include the number of students with whom the material was used.

3) Supportive References:

a) Manual: EPA-EMSL, "Methods for Chemical Analysis of Water and Wastes". This is the reference source of all the methods presented in this course in the Effluent Monitoring Procedure (EMP) format. Address requests for a copy to:

U.S. EPA
Office of Technology Transfer
Industrial Environmental Research Laboratory
Cincinnati, Ohio 45268

b) AV Catalog: NTOTC, "Audiovisual Instructional Units". This is a catalog of slide-tape instructional units developed by the Center. Although not developed specifically for this course, several of the units are on course topics and might be useful supplementary material. Address requests for a copy to NTOTC at the address given in b. 1) a) above.

c) IRIS: A Water Quality Instructional Resources Information System has been developed through an EPA training grant. The "Master Reports" contain availability information and descriptions for 2300 entries of instructional and resource materials. These are printed matter, slides, films, slide-tape units and video tapes developed by varied sources for training personnel involved in all aspects of water quality assessment and control. Thus, IRIS serves as an information source of available, water quality training resources covering a wide range of subjects.

The user does not need data processing equipment to use the system. Four of the commonly used elements of IRIS (Users Manual, Tables, Master Report, Subject Index) are currently available.

(1) While present supplies last, a set is available to qualifying educational institutions and training agencies from NTOTC at the address given in b.1)a) above.

(2) Paper copies can be ordered as a set of four volumes from NTIS (PB-262-223/AS, Set, 1120 pp. "Water Quality Instructional Resources Information System, Volumes I through IV) for $31.00. The NTIS address is given in b.1)c) above. Microfiche copies cost $12.00 per set.

(3) Paper or microfiche copies of individual volumes can also be ordered from NTIS at the address given in b.1)c) above using this information:

(a) PB-262-224/AS, 99 pp., "Water Quality Instructional Resources Information System, Volume I-Users Manual" @ $5.00. (microfiche $3.00)

(b) PB-262-225/AS, 96pp., "Water Quality Instructional Resources Information System, Volume II-IRIS Tables" @ $5.00 (microfiche $3.00)

(c) PB-262-226/AS, 494 pp., "Water Quality Instructional Resource Information System, Volume III - Identification Number Master Report" @ $12.50 (microfiche $3.00)

(d) PB-262-227/AS 431 pp., "Water Quality Instructional Resources Information System, Volume IV - Subject Index" @ $11.75 (microfiche $3.00)

c. Instructional Resources Developed by Other Sources

1) Minimum technical references which should be in possession of the institution include:

a) "Standard Methods for the Examination of Water and Wastewater" (14th ed), APHA, AWWA, WPCF. Available from Publications Office, American Public Health Association, Inc., 1015 18th Street, NW, Washington, D. C., 20036.

b) "Annual Book of Standards" Part 31, "Water", 1975. Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

2) Audiovisual and Other Training Aids

   a) A wide variety of training resources is listed in the EPA sponsored publication, "Water Quality Instructional Resources Information System" (IRIS), cited in b, 3) c) above.

   b) Information on sources of the listed items is provided.

   c) Training institutions having information about training resources applicable to this course, which are not currently listed in IRIS, are invited to relay this information to the Director, National Training and Operational Technology Center. Such resources, as applicable, will be made known to other organizations which could benefit from their use.

d. Instructional Resources Already in Possession of the Training Institution

   1) Many training organizations prefer to develop their own texts and audiovisual training resources.

   2) To the extent that these resources can be released for free reproduction and use by others, institutions are invited to make such resources available to other training organizations.

   3)The National Training and Operational Technology Center is prepared to serve as a focal point for making information about such resources widely available, provided that copyright or other restrictions on reproduction do not limit availability of such materials.

      a) Before encouraging other training institutions to use such resources in relation to this Course, elements of EPA will:

         (1) Review the training resources to determine whether the instruction is consistent with existing laws, regulations, and Agency policy;

         (2) Review the resource for technical validity and educational quality.

      b) Materials found suitable by EPA would be recommended to other institutions known to be presenting this Course.

   4) All training resources referred to NTOTC as available for use by others will be added to the overall inventory listing cited in IRIS, b. 3) c), above. It is hoped that a mutually supportive activity in this area will, in time, result in:

      a) making IRIS a diversified, total resource system for training materials which will be of the highest technical quality;
      b) offering training institutions a wide variety of types of training resources;
      c) reducing the amount of duplication of effort that so often results from lack of information on what is available, from what sources, and how obtained.

REQUEST FOR LOAN
AUDIOVISUAL INSTRUCTIONAL UNIT

Title and Catalog No. ________________________________

____

Intended Use: ___________________________________

____

Preferred Date of Use: ____________________________

Alternate Date: _________________________________

BORROWER'S NAME ______________________________

Title ____

Organization ____________________________________

Address ____

____
(Zip)

Phone Number (include
Area Code): ________________________

There is no charge for use of the Audiovisual Instructional Units. However, the *BORROWER* assumes financial responsibility for the value of all loaned equipment and instructional materials.

Unless special arrangements are made with the loaning office, units should be returned within two weeks. Return the unit by *REGISTERED, CERTIFIED* or *INSURED MAIL IMMEDIATELY* after use.

EPA-171 (Cin)
(8-74)

C. Secretarial Support

The key role of the office worker(s) designated "Course Secretary" cannot be overemphasized.

This function has many elements including being the right arm of the Course Coordinator, being Course Registrar, being Course Secretary and being a "Course Watchdog" to give the alarm when essential milestone stages of course planning and preparation are being overlooked.

In this section, these elements are considered under the headings: Course Records and Record-keeping, Suggested Student Registration Procedures and Printed and Reproduced Materials - Summary.

1. Course Records and Record-keeping

a. General Considerations

1) Complete, detailed, and accurate records should be established for each course presentation. Each course record will be a separate file. In addition to the individual course files, it may be necessary to establish a finder-system for locating the records of individual students.

2) Response to Inquiries about Former Students

   a) Students enroll in this course in order to acquire necessary knowledge and skills to perform the self-monitoring procedures required for municipal effluents.

   b) In many, if not all cases, satisfactory completion of this course will be a factor in the accreditation of individuals to perform the analyses and measurements required for compliance with NPDES Permits.

   c) It is anticipated that numerous inquiries from former students and from regulatory agencies will be addressed to the training institution. Typical requests for information may include any or all of the following:

      (1) Verification of attendance and satisfactory completion of training;

      (2) Identification of the specific analyses and measurements covered in the course, as well as designation of the method which was taught;

      (3) Quality of student performance in the course;

(4) Documentation of any specific analyses, tests, or measurements in which the student did not meet the required standard of performance, and the nature of such failure; and

(5) Documentation of any other events which made the student unusual. This could be a record of exceptionally high performance, or it could be a record of any specific difficulty which arose in connection with the student, within or outside the scheduled training activities.

3) Reports

Most training institutions require submission of periodic reports on progress and achievements. It is safe to predict that management or cognizant regulatory agencies from time to time will call for information not provided in routine reports. If such demands are to be met, complete course records will be the most reliable source for such information.

4) Retention of Records

The length of time course record files should be retained is uncertain, and must be determined by each institution.

Institutions having a system of archives for inactive files may find it convenient to retain course records in active office files for approximately two years, then retire them to archives storage. Institutions not having archives storage probably should retain the complete file on each course presentation for at least five years.

b. Contents of Course Files

1) In the planning and development stage, and until completion of each course presentation, course records are kept most effectively in two sections.

These are:

a) A file folder, kept in the filing cabinet or in the desk of the Course Secretary; and,

b) A student record notebook, usually a 3-ring binder, kept on the Course Secretary's desk, or in a convenient bookcase.

Both sections of the Course files should be maintained by the Course Secretary, and should be made available to other staff members under rigid controls providing for direct examination and immediate return. After completion of the course, the two sections can be combined in a single large file packet for future retention.

2) The file folder is best suited for such records as:

   a) Copies of all correspondence, memoranda, and records of telephonic conferences related to course planning and development;

   b) Copies of course schedules;

   c) Records of equipment and supply acquisition for the course, through purchase or through loan (with information and records on return to owner);

   d) Records of staff assignments, classroom and laboratory reservations;

   e) Copy of course announcement and/or description (See page 12-6);

   f) Sample record copies of all routine informational material sent to students accepted for training; (See pages 12-12 through 17);

   g) Records of arrangements for travel of personnel and transportation of equipment and supplies, arrangements for field facilities, and other records pertaining to a field course; and

   h) Course evaluation commentaries by Course Coordinator and other staff members as appropriate.

3) The student record notebook is best suited as a vehicle for all records and copies of communications related to individual students. This may be organized effectively in a 3-ring notebook, containing separator sheets with alphabetical tabs. The personal records of each student will be retained under the alphabetical tab corresponding with his last name. In the student record notebook may be found:

   a) At the front (before the "A" of the series of tabbed dividers):

      (1) A registration summary sheet showing record of standard communications with each accepted student, fees paid, etc... (See page 12-18);

      (2) A waiting list summary sheet showing record of standard communications with each student placed on a waiting list prior to the course due to early maximum enrollment. (See page 12-19)

      (3) A non-attendance summary sheet showing record of students who applied for admission but could not be admitted for lack of qualification, or due to an already-filled class. This summary also is used to identify applicants who applied for admission, who were admitted, and who failed to appear without due explanation ("no shows"). (See page 12-20);

(4) A summary sheet recording student performance (acceptable or not acceptable) for each of the units of instruction in the course. (Such a summary worksheet has not been developed at the writing of this Guide).

b) In the alphabetical section of the student record notebook, each student's personal record will contain such items as:

(1) The application for admission to training (See pages 12-7 and 8);

(2) Copies of all correspondence with the student (See pages 12-9 through 12), except for the routine local information sheets (See pages 12-13 through 17), one set of which is kept in the loose file folder;

(3) Record copies of student quizzes, data sheets, and other individual records of class performance provided by Instructor. (See pages 12-24 through 38).

(4) Copy of the certificate awarded at end of course which is a record of the measurements completed by the student in a satisfactory manner. (See page 12-23);

(5) Documentation of any information about the student judged to be of possible future concern or inquiry. (An example of such a sheet had not been developed at the time of writing this Guide).

2. Suggested Student Registration Procedures

a. Introduction

1) Purpose

Formal registration and enrollment procedures are intended to assure that:

a) The class consists of students for whom the training is intended and designed;

b) The accepted students meet minimum knowledge and skills required for reasonable assurance of satisfactory completion of the course;

c) Accepted students are provided with adequate pre-training information so that they will make their personal arrangements and travel schedules to assure arrival at the appointed time and place, with full participation throughout the program of training;

d) The size of the class is in accordance with the course plan: and

e) Those not accepted for training are provided with suitable advice which can lead to future admission.

2) Alternative Approaches to Registration

Three different approaches to registration are considered here, though only the first is described in detail. Most details of the second and third identified alternatives can be inferred through study of the first alternative. The three approaches considered are:

a) Registration by priority of receipt of application;

b) Registration by comparative evaluation of all applicants; and

c) Registration for special course offering at request of another organization. Students are nominated by the requesting organization and are accepted without further evaluation of entry-level qualifications by the training institution.

b. Registration by Priority of Receipt of Application (Recommended)

1) Applicant

a) Receives course announcement;

b) Completes application and secures internal approvals as required in his own organization;

c) Mails application to registration office of the institution conducting the training.

2) Course Secretary

a) Receives application;

b) As received, checks status of registration for availability of class space, and makes appropriate notation on the application or on attached transmittal slip;

c) Depending on b), records application either in the registration summary, or the waiting list summary, in front of student notebook;

d) Delivers application to Course Coordinator.

3) Course Coordinator

a) Evaluates the student application and the space availability situation;

b) Directs the Course Secretary by notation on the application to:

(1) Accept the applicant, or

(2) Notify the applicant of closed class enrollment, or

(3) Refer the applicant to the "Basic Laboratory Skills" course before entry into this course;

c) Prepares a special letter for non-admissable applicants (or memorandum record of other form of communication with applicant) which sets forth the reasons why the applicant is being rejected. Because of the compulsory nature of the self-monitoring tests on municipal effluents for NPDES Permit compliance, rejection of a bona fide applicant may be a very serious matter, and should be handled with care.

4) The Course Secretary

a) Prepares a standard letter or special letter as directed, and obtains signature of Course Coordinator:

b) Places a file copy of the letter and the application in the appropriate place under the alphabetical tab section of the student record notebook;

c) Mails the original letter to the applicant, and records the the date of mailing in the appropriate place in the summary records at the front of the student notebook.

d) Approximately 30 days before the course, mails to each accepted applicant a standard communication, consisting of

(1) A form letter of welcome to the course, including information on starting and closing dates and hours of the course, directions and how to proceed to the classroom area, and related information (See page 12-9); and

(2) Local information helpful to outside visitors, such as hotel/motel information, local transportation and schedules, a schematic map of the area, and related information. (See pages 12-13 through 17);

e) Records the mailing of the standard packet on the registration summary sheet.

f) When applications are still being accepted within 30 days before the start of the course, includes the general informational material with the letter of acceptance for admission.

g) On the first day of the course:

(1) Obtains a detailed registration card from each student. Some institutions may dispense with this record, though it can be of value in report preparation (See page 12-21);

(2) Prepares any registration tallies required by requesting organization(s) and/or administrative regulations. (See page 12-22);

(3) Prepares a class roster of those in attendance, distributes to class, staff, and keeps a permanent record copy in course files;

(4) Records any "no shows" (applicants accepted for training but who did not appear) on the student non-attendance summary record sheet. (See page 12-20)

c. Registration by Comparative Evaluation of all Applicants

1) Applicant

a) Receives course announcement;

b) Completes application and secures internal approvals as required in his own organization;

c) Mails application to registration office of the institution conducting the training.

2) The Course Secretary

a) Receives the applications;

b) Records receipt of application in a summary record in student record notebook;

c) Files application in student notebook;

d) Sends standardized letter acknowledging the application, and briefly explaining the registration procedure, with assurance that decision on admission will be announced not less than 30 days prior to start of the course;

e) Delivers all applications to the Course Coordinator , approximately 35 days before start of the course.

3) The Course Coordinator

a) Reviews and evaluates all applications;

b) Selects students to be admitted for training;

c) Directs Course Secretary to send appropriate standardized letters and information packets as described in b. above;

d) Special note should be taken of the particular attention which should be given to rejected applicants. See b., 3), c). above.

4) The Course Secretary

a) Sends communications;

b) Prepares records and student files as described in b.4) above.

d. Registration for Special Course Offering

Here a requesting organization has designated a student body which it wishes to have trained. It is the duty of the training institution to provide the requesting organization with admission standards for the course. It becomes the duty of the requesting organization to screen its candidates for conformance to these standards, and to provide the training institution with the names of the students to be trained. The requesting organization usually notifies the students.

1) For record purposes, it is best that students complete a course application form, though it will not be evaluated as in b. and c. above.

2) On receipt in the training institution, the Course Secretary makes the necessary entries showing record of receipt and class composition. Files are kept in the usual way. Approximately 30 days before the course, the individual standardized welcome and information packets are sent to students in the usual way. The training organization follows its usual practices in preparation of records, rosters, and any other data required for reports.

3. Printed and Reproduced Materials - Summary

a. General Information

In addition to the student reference text, standardized letters and administrative forms/materials, presentation of this course also requires calculation forms, laboratory data sheets, and graph forms which must be prepared in quantity by the Course Secretary.

1) In the following summarizing table, all of the standardized materials noted above are identified and supported with additional information on due date, the number to be prepared (for a class of 18 students), and the ultimate fate of the materials in permanent course records. Institutions offering this course may find it necessary to add to or to modify these standardized materials. It is suggested that plans to do so be noted on the summarizing table, with samples or examples provided on separate pages.

2) A sample or example of each item listed (except the student reference text) is shown following the summarizing table.

a) Samples can be copied directly, if meeting requirements of the training institution.

b) The examples are shown in recognition that a corresponding item probably will be needed by the training institution, but probably will have to be modified to fit the situation.

b. Responsibilities for Printed and Reproduced Material

1) Course Coordinator

a) Reviews the administrative materials for conformance to the requirements of the regulatory authority;

b) Makes modifications as necessary to the samples and examples provided in this Guide;

c) Decides upon and designs any additional administrative documents or records needed; and

d) Provides the Course Secretary with complete identification of material to be copied directly or to be modified, and also provides samples of any new material required for course administration.

2) Instructors

a) Review all materials identified for the procedures for which they have instructional responsibility;

b) Design new supportive instructional material as required; and

c) Provide the Course Secretary with complete information on material to be copied directly or to be modified, and also provide samples of any new material required for student instruction.

3) Course Secretary

a) Receives from Course Coordinator and Instructors identification of existing materials, samples of modified and new material;

b) Adds to the summarizing table, in the appropriate locations, the identifying information, together with the supporting information on due date, quantity, confidentiality, and ultimate fate of any new or revised material designed by Course Coordinator or by Instructors;

c) Reproduces, or arranges reproduction of, the needed course materials so that they will be available for use at the time and place required.

c. Special Warnings

1) All staff members should be particularly alert to adjustments in "Due Date" which must be made when the course is conducted in the field, if training equipment and supplies must be shipped to the course site.

2) Preparation of these training materials is a potential source for great difficulty in course development and presentation. Few activities in course planning and development require a greater amount of effective teamwork among all staff members. The greatest problem here is one of timing.

a) All staff members must provide necessary information and samples of new or modified materials with adequate lead time to meet "Due Dates." The amount of lead time is not specified here; this will vary from one institution to another.

b) The Course Secretary must be diligent in advising Course Coordinator and Instructors of impending logistic problems if delays occur in submission of materials, and must give prompt attention to printing or reproduction of needed materials when delivered by staff members.

c) The author of this Guide ruefully confesses that the worst and most frequent breakdowns in this area usually are the result of belated delivery of needed material from Instructional Staff to the Course Secretary.

SUMMARY OF REQUIRED PRINTED/REPRODUCED MATERIAL

Description	Lesson	When Needed	Number to be Prepared	Confidential ?	Permanent Record?	Remarks
Administrative						
Course Announcement	-	6 months before course	Indeterminate	No	1 copy	Distribute to target group 6 months before course. See 12 - 6
Course Description	-	6 months before course	Indeterminate	No	1 copy	Same as announcement. Can be used in conjunction with chronological course listings. See 12-6
Application for Admission	-	6 months before course		No	No	Usually part of course announcement. May be separate sheet. See 12 -7
Verification of Basic Laboratory Skills	-	6 months before course	Indeterminate	No	1 copy	Attached to application form. See 12 - 8
Standard Letter: Acceptance	-	5 months before course	100	No	No	Copies will show up in student files. See 12 - 9
Standard Letter: Standby: Full Class - Waiting List	-	5 months before course	100	No	No	Copies will show up in student files. See 12 - 10
Standard Letter: Referral to Basic Lab Skills Course	-	5 months before course	100	No	No	Copies will show up in student files. See 12 - 11
Standard Letter: Welcome and Local Information: Hotels/Motels, Transportation Schedule, Schematic Area Map Classroom Location	-	30 days before course	100	No	1 copy	In Course file folder. See 12 - 12 through 12 - 17
Registration Summary Record	-	5 months before course	1	No	Yes	In Registrar's three-ring notebook. See 12 - 18

Description	Lesson	When Needed	Number to be Prepared	Confidential ?	Permanent Record?	Remarks
Administrative (Cont'd.)						
Waiting List Summary	-	90 days before course	1	No	Yes	In Registrar's three-ring notebook. See 12 - 19
Non-attendance Summary	-	First day of Course	1	No	Yes	In Registrar's three-ring notebook. See 12 - 20
Trainee Registration Card	-	First day of course	20	No	Yes	Institution's Records See 12 - 21
Registration Tally and Class Roster	-	First day of course	As required	No	Yes	In course file folder See 12 - 22
Course Certificates	-	Final day of course	18	No	Yes	In student file See 12 - 23
Classroom/Laboratory **Microbiology (MPN**						
Test #1	1 of 10	Day 2	20	Yes	Yes	Keep test papers, or summary of scores with one sample of test. See 12 - 24 to 12 - 26.
Test #2	2 of 10	Day 2	20	Yes	Yes	Keep test papers, or summary of scores with one sample of test. See 12 - 27 to 12 - 28
Assignment Sheet	3 of 10	Day 2	20	No	1 copy	See 12 - 29
Lab Data Sheet	4 of 10	Day 2	50	No	Yes	One copy of each student's data sheet after completion of lesson 10. Distribute 2 copies of data sheet to each student. See 12 - 30 to 12 - 36
Simulated Lab Data	9 of 10	Day 4	20 sets	No	1 set	These are sets of 8 simulated data sheets. See 12 - 37
Summary of Student Performance	10 of 10	Day 5	1	No	Yes	12 - 38

SUMMARY OF REQUIRED PRINTED/REPRODUCED MATERIAL

Description	Lesson	When Needed	Number to be Prepared	Confidential ?	Permanent Record?	Remarks
Classroom/Laboratory						
pH Determination Laboratory Results	1 of 1	Day 2	20	No	Yes	Keep data sheets or summary of results. See 12 - 39
Instructional Quiz	1 of 1	Day 2	40	Yes	Yes	Keep test papers or summary of results and dispose of test papers. See 12 - 40
Suspended Solids Data Sheet	2 of 6	Day 4	40	No	Yes	Keep one copy of each student's data sheet or a summary of class results (Same as page 11-32 in Suspended Solids EMP. See 12 - 42

Example: For preparation as a 3-fold flyer, with mailing address shown on back.

THE NATIONAL TRAINING CENTER

CINCINNATI, OHIO 45268

ANOUNCES A SPECIAL OFFERING OF THE FOLLOWING COURSE

SELF-MONITORING PROCEDURES: BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS

May 15-19, 1978

COURSE DESCRIPTION

This course is designed for the treatment plant operator or technician who is required to monitor effluent discharges under a National Pollutant Discharge Elimination System (NPDES) Permit, and who has had little or no previous experience in wastewater analysis or flow measurement.

Parameters included in this course are BOD_5, pH, Fecal Coliform, Residual Chlorine, Suspended Solids, and Open Channel Flow. At the conclusion of this training the student will be familiar with the standard test procedure for each parameter, will have performed each analysis, and will be able to use a parshall flume or weir to measure effluent flow. He will also know what equipment and supplies are needed in connection with each procedure.

PRE-REQUISITES

Participant should have ability to perform basic mathematical calculations using both whole numbers, fractions and decimals. Self-Monitoring Procedures: The Course - "Basic Laboratory Skills" or equivalent experience is pre-requisite for the course.

TUITION

A tuition fee of $280.00 is required for attendance at this training course.

APPLICATION FOR TRAINING

Yes I would like to attend the special offering of training course (164.1) ☐

My employer will pay the tuition fee ☐

My employer will apply for waiver of fee ☐

NAME ____________________

ADDRESS ____________________

____________________ ZIP ______

PHONE ____________________

SAMPLE *SAMPLE*

COURSE APPLICATION FORM

1. **Name of Applicant:** Mr. Miss Mrs. (last) (first) (middle initial)

2. **Course desired:**
   Course Title ______ Course No. ______
   Place where given ______ Dates ______

3. **Previous Courses Attended:**
   Course Title ______ Dates ______
   Course Title ______ Dates ______
   Course Title ______ Dates ______

4. **Sponsor or Employer:**
   (name of organization or firm)
   (street address)
   (city) (state) (zip code) (telephone)

5. **Mailing address of applicant:**
   (if different from above)
   (street address)
   (city) (state) (zip code) (telephone)

6. **Job Duties:** (Briefly describe your present position)

7. **Education:** Last year of school completed ______

8. **Experience:** Total years in wastewater treatment plant work ______

9. **Student Skills Checklist:** This checklist must be submitted before Application can be processed.

______
signature of supervisor (where applicable) title

______
signature of applicant date

(SAMPLE STUDENT SKILLS CHECKLIST)

Name ______________________________

Employer ______________________________

To assist us in processing applications, please check YES or NO for each of the following items:

	YES	NO
I have operated a laboratory gas burner	___	___
I have operated a laboratory hotplate/stirrer	___	___
I have operated an autoclave	___	___
I have operated a laboratory drying oven	___	___
I have used a vacuum source to filter liquids	___	___
I have used a desiccator	___	___
I have weighed items on an analytical balance	___	___
I have weighed items on a single pan balance	___	___
I have used a graduate to measure liquids	___	___
I have used a volumetric pipet to measure liquids	___	___
I have used a graduated (Mohr) pipet to measure liquids	___	___
I have used a pipet bulb to fill a pipet	___	___
I have used a volumetric flask to prepare solutions	___	___
I have used chromic acid to clean glassware	___	___
I have operated a laboratory safety shower	___	___
I have operated a laboratory eye washer	___	___
I have operated a fume hood	___	___
I have prepared 0.0375N potassium biiodate solution	___	___
I have made out labels for bottles of reagents	___	___
I have recorded a reading at a meniscus	___	___
I have titrated one solution against another to a color change end point	___	___
I have calculated the normality (N) of a solution	___	___
I have recorded laboratory data in a laboratory notebook	___	___
I have entered laboratory data on a pre-printed form	___	___
I have recorded information about samples on record sheets	___	___
I have located required purchase information in a catalog of laboratory equipment	___	___
I have written a purchase order for chemicals	___	___
Volume means space occupied by a solid, liquid, or gas	___	___
mg/l means milligrams per liter	___	___
1 kilogram equals 0.001 gram	___	___
1 inch equals 2.54 cm	___	___
1000 ml equals 1 liter	___	___
85 times 4.1 equals 42.5	___	___
7 minus 2 divided by 0.02 equals 250	___	___
3.26 rounded to the nearest tenth is 32.6	___	___
84.55147 rounded to the nearest thousandth is 84.551	___	___

(SAMPLE LETTER OF ACCEPTANCE FOR TRAINING)

(Institutional Letterhead)

(Date)

To

Dear (Name):

A reservation has been confirmed for your participation in the course "Self-Monitoring Procedures: Basic Parameters for Municipal Effluents" to be conducted at (address, including building and room identification if pertinent).

Formal class activities will begin promptly at 8:30 AM on Monday, (date) and the course will be completed by 12:30 PM on Friday, (date). Please arrange your travel schedule so that you will be in the classroom at the start of course activities on Monday and that you will not have to hurry your departure on Friday.

Information about local travel, transportation, and local hotels is enclosed for your assistance. We believe that you will wish to make your own hotel or motel reservations.

We look forward to seeing you at the course, and we will do everything in our power to make this course a pleasant and rewarding experience for you.

Sincerely yours,

(signature)
Course Coordinator

Note: If something develops which makes it impossible for you to attend the course, please telephone (number) or write this office immediately, in order that another applicant may be admitted to the course in your place. Please do not arrange for a substitute without first getting the approval of this office.

(SAMPLE STANDBY LETTER)

(Institutional Letterhead)

(Date)

To

Dear (Name):

We have received your application for admission to the course "Self-Monitoring Procedures: Basic Parameters for Municipal Effluents," to be conducted at (name of institution) during the period (date to date).

We would be most pleased to enroll you in this course, but by the time we received your application, all available positions in the class had been reserved. As you may know, we limit the class size to a fixed number in order to provide for the greatest possible amount of personal instruction during the course, and to provide each participant with the greatest possible opportunity for actual practice in the laboratory.

We have made a tentative reservation for you in the next offering of the course, which is scheduled to be given (dates). If this will be satisfactory to you, please write or call us within (number) days, so that we can confirm your reservation.

In the meantime, we have placed your name on the waiting list for the course dates which you requested. If a vacancy does become available, we will let you know immediately.

Sincerely yours

(signature)
Course Coordinator

(SAMPLE LETTER OF REFERRAL)

(Institutional Letterhead)

(Date)

To

Dear (Name):

We have received your application for admission to the course "Self-Monitoring Procedures: Basic Parameters for Municipal Effluents," to be conducted at (name of institution) during the period (date to date).

Based on our review of your previous laboratory experience, we consider that it would be very doubtful whether this course would provide you with all the knowledge and skills you will require to perform the self-monitoring tests and measurements on your municipal wastewater effluents.

Accordingly, we are confirming your reservation in this course, subject to your first satisfactorily completing the course (title of "basic skills" course). This course will be conducted at (location) (dates). We have made a tentative reservation for you to attend this course. Please let us know if you can attend this offering of the course.

If you must delay taking the course (name of "basic skills" course) at this time, then it will be necessary to delay your acceptance in the course which you have requested.

In the course (name of "basic skills" course) you will learn many things not covered in the later course, including use of the analytical balance, preparation and standardization of laboratory reagents and culture media, care and maintenance of laboratory supplies and equipment, and related tasks.

We are most anxious to help you learn to perform all the tasks required for self-monitoring of your municipal wastewater effluents. Please let us know if you can come to both courses.

Sincerely yours,

(signature)
Course Coordinator

(EXAMPLE)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

TO: COURSE PARTICIPANTS --

We are looking forward to your participation in the course, "Self-Monitoring Procedures: Basic Parameters for Municipal Effluents," scheduled for presentation at this Center during the period May 15-19, 1978. If you find you cannot attend the course, please call us (513 684-8228).

To assist your planning and preparation for this course, the following items are enclosed:

1. List of hotels and motels
2. Information on local bus transportation and city map, (NOTE: If bus service is used to the Center, you must have exact fare of $ .25 on boarding bus).

On your arrival in the classroom you will be provided a course manual and related materials. Production schedules make it impossible to mail manuals to you in advance of course date.

The course will start at 8:30 AM on Monday, May 15 in Classroom B-56 and will close no later than 4:30 PM, Friday, May 19. At the conclusion of the course, a certificate will be awarded the participants who have attended all sessions and met the training objectives. Please arrange your travel schedule after closing exercises. (Approximately 1-1/2 hours should be allowed for travel from the Center to the airport.)

Should you have questions or desire assistance in any way, please do not hesitate to contact us.

Sincerely yours,

(Signature)
Course Coordinator

DOWNTOWN AND SUBURBAN HOTELS AND MOTELS

CINCINNATIAN HOTEL
6th & Vine Sts., 45202
Phone: 241-0180
Single $3.50 - $6.45
Double $8.60 - $10.75
Twin $10.75
222 Rooms
Meeting Room 1 - Capacity 25
TV, restaurant adjoining

EL RANCHO RANKIN MOTEL
521-5298 Beechmont Ave., 45230
Phone: 231-4000, Rts. 50 & 125, 1-1/4 miles S.E.
Single $12.50, Double $15 - up, twin $15 - up,
Family plan, 127 rms, meeting rooms 5-
cap. 50-300, heated swimming pool and health club.
Kitchenettes, banquet rooms, 5 dining rooms, cocktail
lounge, bar

HOLIDAY INN - DOWNTOWN
8th & Linn Sts., 45203, Phone: 241-8660,
2 miles W., single $15, double $22, twin $24,
245 rooms, meeting rooms 4 - cap. 25-135
Swimming pool, TV, 2 dining rooms, and bars,
night club "Top of the Inn" (entertainment nightly)

MARIEMONT INN
6880 Wooster Pike, 45227, Phone: 271-2100,
Rt. 50, 17 miles E., single $11 - $14, double
$13 - $18, 53 rooms, meeting rooms 7 - cap. 150,
restaurant, TV, coffee shop, beauty shop, cocktail
lounge

NETHERLAND HILTON HOTEL
35 W. 5th St. 45202, Phone: 621-3800, single $17,
double $23, twin $23 and up, family plan, 800 rooms,
TV, meeting rooms 15 - cap. 70-1500, special Gov't.
rates - $13 single, $19 double

QUALITY MOTEL
4747 Montgomery Rd., 45212, Phone: 351-6000,
single $17, double $22, nearly new, nine-story,
TV, restaurant. Gov't. rates - $13.50 single,
$18.50 - double.

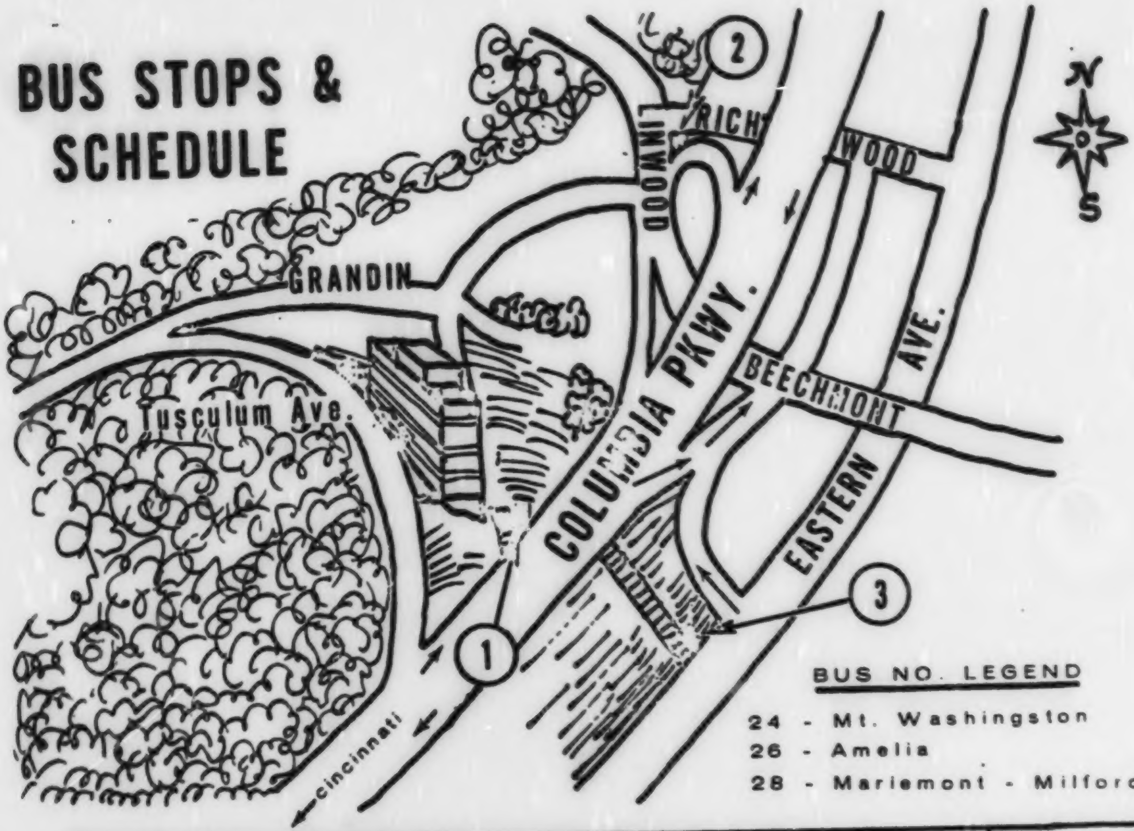
STOUFFER'S CINCINNATI INN
150 W. 5th St. 45202, Phone: 721-8600, single $19 -
$22, double $25 - $28, twin $27, 462 rooms, meeting
rooms 11, cap. 50-550, swimming pool, cocktail lounge
sauna bath, color TV. Gov't. rates - $17 single, $23.50 double.

TERRACE HILTON HOTEL
15 W. 6th St. 45201, Phone: 381-4000, single $19, double $25, twin $25, family plan, 350 rooms, meeting rooms 4 - cap. 75-400, color TV, special Gov't. rates - $14 single, $20 double

NOTE: We recommend you checking the rate at the time you make your reservation in the event there has been a price increase.

These hotels and motels are listed for your information to assist you in planning for your accommodations during your stay in Cincinnati while attending our training course, and does not imply endorsement by the Office of Water Programs, Environmental Protection Agency.

BUS STOPS & SCHEDULE


N
S
2
RICH
WOOD
INWOOD
GRANDIN
COLUMBIA PKWY.
BEECHMONT
AVE.
EASTERN
Tusculum Ave.
1
3
cincinnati

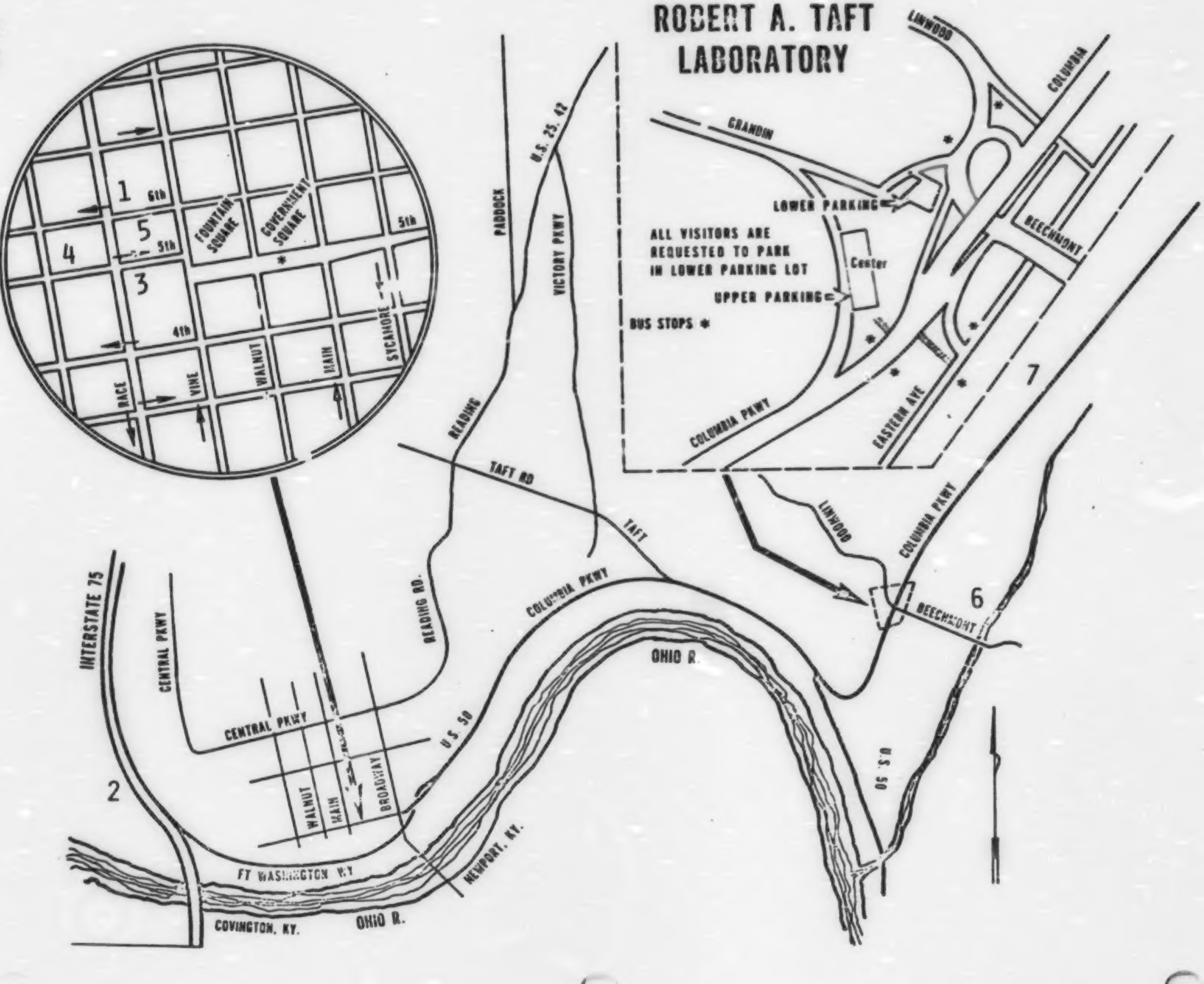
BUS NO. LEGEND

24 - Mt. Washingston
26 - Amelia
28 - Mariemont - Milford

Lv. Gov't. Square	Bus No.	Bus Stop	Arr. Taft Center	Lv. Gov't Square	Bus No.	Bus Stop	Arr. Taft Center
7:00 A.M.	28	1	7:20 A.M.	7:45 A.M.	28	1	8:00 A.M.
6:57A.M.	26	1	7:13 A.M.	8:20 A.M.	26	1	8:36 A.M.
7:35 A.M.	28	1	7:50 A.M.	9:25 A.M.	28	1	9:40 A.M.

Lv. Taft Center	Bus No.	Bus Stop	Arr. Gov't. Square	Lv. Taft Center	Bus No.	Bus Stop	Arr. Gov't. Square
10:50 A.M.	28	1	11:15 A.M.	3:16 P.M.	24	2	3:54 P.M.
12:12 P.M.	24	2	12:44 P.M.	4:15 P.M.	26	1	4:36 P.M.
12:47 P.M.	26	1	1:06 P.M.	4:40 P.M.	28	1	5:12 P.M.
				4:58 P.M.	26	1	5:20 P.M.
2:41 P.M.	28	1	3:00 P.M.	5:12 P.M.	24	2	5:47 P.M.

ROBERT A. TAFT LABORATORY


ALL VISITORS ARE REQUESTED TO PARK IN LOWER PARKING LOT
BUS STOPS *
LOWER PARKING
UPPER PARKING
Center
LINWOOD
COLUMBIA
GRANDIN
BEECHMONT
EASTERN AVE
COLUMBIA PKWY
7
6
LINWOOD
BEECHMONT
COLUMBIA PKWY
U.S. 50
OHIO R.
TAFT
TAFT RD
VICTORY PKWY
U.S. 25, 42
PADDOCK
READING
READING RD.
COLUMBIA PKWY
U.S. 50
CENTRAL PKWY
CENTRAL PKWY
BROADWAY
MAIN
WALNUT
NEWPORT, KY.
FT WASHINGTON WY
COVINGTON, KY.
OHIO R.
INTERSTATE 75
2
1
6th
5
5th
4
3
4th
FOUNTAIN SQUARE
GOVERNMENT SQUARE
5th
SYCAMORE
MAIN
WALNUT
VINE
RACE

EXAMPLE

DOWNTOWN AND SUBURBAN HOTELS AND MOTELS

MOTEL	DISTANCE FROM TAFT CENTER	TRANSPORTATION PROVIDED	RATES SINGLE	RATES DOUBLE
1. Cincinnatian*	7 miles	City bus from Gov't. Square	$ 7.50	$ 9.50
2. Holiday Inn	8 miles	None	15.00	22.00
3. Netherland Hilton*	7 miles	City bus from Gov't. Square	13.00	19.00
4. Stouffer's Motor Inn*	7 miles	" " " " "	17.00	23.50
5. Terrace Hilton*	7 miles	" " " " "	14.00	20.00
		SUBURBAN		
6. El Rancho Rankin	1 mile	Yes	12.50	15.00
7. Mariemont Inn	2.5 miles	Yes**	11.00 up	13.00
Quality Motel	5 miles	Yes (5 or more students)	13.50	18.50

* Convenient to bus

** Transportation provided for 8 or more persons.

SAMPLE

Course Title

Dates

R E G I S T R A T I O N

INDIVIDUAL	WORD REC'D	APPL. REC'D	ACCEPT. SENT	COURSE INFO. SENT

SAMPLE

WAITING LIST

INDIVIDUAL	WORD REC'D	APPL. REC'D	ACTION TAKEN

SAMPLE

____
Course Title

____
Dates

Not Admitted
Lack of Space ______________________________

No Shows ______________________________

TRAINEE REGISTRATION RECORD
EPA-166 (CIN), (Rev. 4.73)

COURSE TITLE

DATES

COURSE NUMBER

NAME (*Last, First, M.I.*)

U.S. CITIZEN ☐ YES ☐ NO

IF NO, LIST FOREIGN COUNTRY

POSITION TITLE

LOCATION OF TRAINING

EMPLOYER (*Name, address, city, state, zip code*)

LOCAL RESIDENCE DURING COURSE

COURSE MODERATOR

	"X" ONE ITEM IN EACH CATEGORY ONLY	"X"
EMPLOYER CATEGORY	EPA	
	DI	
	DHEW	
	DEPT. OF DEFENSE	
	OTHER FEDERAL *	
	STATE GOVERNMENT	
	LOCAL GOVERNMENT	
	FOREIGN GOV'T	
	UNIV. FACULTY	
	UNIV. STUDENT	
	INDUSTRY	
	CONSULTANT	
	REGIONAL AGENCY	
	OTHER *	
	SPECIFY *	
YEARS OF PROFESSIONAL EXPERIENCE	0–1 YEARS	
	2–4	
	5–7	
	8–10	
	11–15	
	16–20	
	21 OR OVER	
PROFESSION OR OCCUPATION	ADMINISTRATOR	
	BIOLOGIST	
	CHEMIST	
	CIVIC ORGANIZATION*	
	CONSERVATIONIST	
	EDUCATOR	
	ENGINEER *	
	GEOLOGIST	
	MICROBIOLOGIST	
	OCEANOGRAPHER	
	PHARMACIST	
	SANITARIAN	
	STATISTICIAN	
	TECHNICIAN	
	TREATMENT PLANT OPERATOR	
	OTHER *	
	SPECIFY *	
EDUCATION	HIGH SCHOOL NON-GRADUATE	
	HIGH SCHOOL GRADUATE	
	COLLEGE NON-GRADUATE 1–3 YEARS	
	COLLEGE NON-GRADUATE OVER 3 YEARS	
	BACHELOR DEGREE	
	MASTER DEGREE	
	DOCTOR DEGREE	
	OTHER (*describe*)	

COURSE SUMMARY RECORD
EPA 165 (CIN). (Rev. 7.73)

LOCATION OF TRAINING

COURSE TITLE

COURSE DIRECTOR

COURSE MODERATOR

DATES

COURSE NUMBER

NO. OF TRAINEES

ITEM	TALLY	TOTAL	
EPA			EMPLOYER CATEGORY
DI.			
DHEW			
DEPT. OF DEFENSE			
OTHER FEDERAL			
STATE			
LOCAL			
FOREIGN GOV'T			
UNIV. FACULTY			
UNIV. STUDENT			
INDUSTRY			
CONSULTANT			
REGIONAL AGENCY			
OTHER			
0-1 YEARS			YEARS OF PROFESSIONAL EXPERIENCE
2-4			
5-7			
8-10			
11-15			
16-20			
21 OR OVER			
ADMINISTRATOR			PROFESSION OR OCCUPATION
BIOLOGIST			
CHEMIST			
CIVIC ORG.			
CONSERVATIONIST			
EDUCATOR			
ENGINEER			
GEOLOGIST			
MICROBIOLOGIST			
OCEANOGRAPHER			
PHARMACIST			
SANITARIAN			
STATISTICIAN			
TECHNICIAN			
TREAT PLANT OPER			
HS NON-GRAD			EDUCATION
HS GRAD			
COL 1-3 YEARS			
COL OVER 3 YEARS			
BACHELOR DEGREE			
MASTER DEGREE			
DOCTOR DEGREE			
TUITION WAIVED			
EPA			
PAID			
WAIVERS REQUESTED			

BY STATE OR COUNTRY OF EMPLOYMENT

AREA	TALLY	TOTAL
ALABAMA		
ALASKA		
ARIZONA		
ARKANSAS		
CALIF.		
COLO.		
CONN.		
DELAWARE		
D. C.		
FLORIDA		
GEORGIA		
HAWAII		
IDAHO		
ILLINOIS		
INDIANA		
IOWA		
KANSAS		
KY.		
LA.		
MAINE		
MD.		
MASS.		
MICHIGAN		
MINN.		
MISS.		
MISSOURI		
MONTANA		
NEBRASKA		
NEVADA		
N. H.		
N. J.		
N. MEXICO		
NEW YORK		
N. C.		
N. D.		
OHIO		
OKLA.		
OREGON		
PENN.		
R. I.		
S. C.		
S. D.		
TENN.		
TEXAS		
UTAH		
VERMONT		
VIRGINIA		
WASH.		
W. VA.		
WISC.		
WYOMING		

U.S. ENVIRONMENTAL PROTECTION AGENCY

Water Programs Operations

NATIONAL TRAINING CENTER CINCINNATI, OHIO

This certifies that

THOMAS JONES

has completed the course

Self-Monitoring Procedures: Basic Parameters for Municipal Effluents (164.1)

and has been judged proficient in the conduct of the following parameters:

Measurement of pH ______________ Instructor

Treatment Plant Flow Measurement ______________ Instructor

Fecal Coliform Determination ______________ Instructor

Measurement of Biochemical Oxygen Demand ______________ Instructor

Measurement of Suspended Solids ______________ Instructor

EXAMPLE

______________ Director, National Training Center

______________ Course Director

SAMPLE

TEST #1 Name__________________________

EMP: FECAL COLIFORM TEST

Instructions: Place an X in the spaces ( ) which correctly apply to the statements made. Unless otherwise instructed, this is an "open book" quiz.

Example: The author(s) of the procedure used here for testing for fecal coliforms is/are:

(x) Rocco Russomanno
( ) Audrey Donahue
( ) Charles Feldmann
(x) Harold Jeter

1. The test procedures described in this body of instruction may be variously known as the

( ) Standard Plate Count Method
( ) Multiple Dilution Tube Method
( ) Most Probable Number Method
( ) Membrane Filter Method
( ) MPN Method

2. The purpose of the fecal coliform test is to determine whether

( ) The effluent from the wastewater treatment plant contains pathogenic (disease-causing bacteria
( ) The bacteriological quality of the effluent meets requirements set for the plant by the State or other authorities
( ) The water is safe to drink
( ) The effluent water should be recycled through the treatment plant for further reduction of bacteria.

3. To perform the fecal coliform test, measured sample portions are first delivered into

( ) Lactose Lauryl Sulfate Tryptose Broth
( ) EC Broth
( ) Water Bath Incubator
( ) 35°C Air Incubator

TEST #1 - EMP: Fecal Coliform

4. Lactose Lauryl Sulfate Tryptose Broth may be abbreviated as

( ) EC
( ) LST
( ) BGLB
( ) LLSTB

5. EC Broth may be identified in abbreviated form as

( ) EC
( ) LST
( ) BGEC
( ) LLSTB

6. After 24 hours, incubation in the first medium, the cultures are examined, and a "+" result reported if --

( ) growth occurred in the tubes
( ) gas was present in the tubes
( ) gas was absent in the tubes
( ) fecal coliforms were present

7. Transfers are made from --

( ) tubes showing gas in the first medium --
( ) tubes not showing gas in the first medium --
to ( ) Lactose Lauryl Sulfate Tryptose Broth
( ) Eosin Methylene Blue Agar
( ) EC Broth
( ) Brilliant Green Lactose Bile Broth

8. After inoculation of the sample into the first culture medium and incubator, the results are "negative" if --

( ) growth has not occurred within 24 hours
( ) gas has not appeared within 24 hours
( ) gas has not appeared within 48 hours
( ) gas has not appeared within 72 hours

TEST #1 - EMP: Fecal Coliform

9. After transfer from the first medium, the results are declared "positive" on the second medium if --
    - ( ) gas has appeared within 1 hour
    - ( ) growth has appeared within 24 hours
    - ( ) gas has appeared within 24 hours
    - ( ) gas has appeared within 48 hours

10. Incubation of the tubes in the first medium is --
    - ( ) in an air incubator set at 35°C ± 0.5°C
    - ( ) in an air incubator set at 44.5°C ± 0.2°C
    - ( ) in a water bath incubator set at 37°C ± 0.5°C
    - ( ) in a water bath incubator set at 44.5°C ± 0.2°C

11. Once the sample has been inoculated into the first culture medium, the test for fecal coliform bacteria may require up to
    - ( ) 1 hour
    - ( ) 24 hours
    - ( ) 48 hours
    - ( ) 72 hours
    - ( ) 96 hours

SAMPLE

TEST #2 Name ____________________

EMP: FECAL COLIFORM TEST

1. The waterbath incubator is to be operated at
   - ( ) 35°C ± 0.5°C
   - ( ) 35°C ± 0.2°C
   - ( ) 44.5°C ± 0.5°C
   - ( ) 44.5°C ± 0.2°C
2. The air incubator is to be operated at
   - ( ) 35°C ± 0.5°C
   - ( ) 35°C ± 0.2°C
   - ( ) 44.5°C ± 0.5°C
   - ( ) 44.5°C ± 0.2°C
3. The autoclave is acceptable for
   - ( ) sterilization of culture media
   - ( ) sterilization of used cultures
   - ( ) sterilization of dry glassware
   - ( ) preparation of distilled water
4. The autoclave is operated at
   - ( ) 35°C
   - ( ) 44.5°C
   - ( ) 121°C
   - ( ) 170°C - 180°C
5. Disinfectant solution is used
   - ( ) to rinse the hands after working with cultures
   - ( ) to wash the laboratory bench at the beginning of each day's work
   - ( ) to sterilize used cultures before draining the tubes for washing of the glassware
   - ( ) to wash the laboratory bench at the end of each day's work

6. Fermentation tube assemblies

   ( ) are used to prepare sample dilutions

   ( ) are used to contain culture media to demonstrate gas production from special culture media

   ( ) consist of a large culture tube with a cap and an inner, smaller, inverted glass tube.

   ( ) must be assembled from different components which are ordered separately

   ( ) are purchased as complete assemblies.

7. Pipettes --

   ( ) are used to transfer a culture from one medium to another

   ( ) are used to deliver a measured sample portion into a culture medium

   ( ) may be made of glass, copper, or plastic

   ( ) are sterilized in disinfecting solution

   ( ) do not have to be sterilized for use in the bacteriology laboratory.

8. In deciding how large an incubator to buy, it is best to select

   ( ) the largest and most expensive one that the laboratory budget will permit

   ( ) one which has shelf space enough to accept the number of racks of new cultures to be inoculated on any given day.

   ( ) one which has shelf space enough to accept about three times the number of racks of new cultures to be inoculated on any given day.

9. The inoculation loop --

   ( ) is used to inoculate a sample into the first culture medium in the fecal coliform test

   ( ) is used to transfer a culture from one culture medium to another

   ( ) should be made of 26 B and S gauge wire

   ( ) should be 4 - 5 mm in diameter

   ( ) may be made of any kind of wire, such as copper, platinum, nichrome, or iron.

SAMPLE

EMP - Fecal Coliform
Lesson 3

ASSIGNMENT: Same to all students

1. Prepare 300 ml of EC Broth.

2. Dispense the medium in 10-ml increments into the 25 fermentation tube assemblies prepared in Lesson 4.

   a. Use a 10-ml pipette for about half of the tubes.

   b. For the remainder of the tubes, use a funnel-with-pinchcock assembly which the staff will have prepared for your use. Make a note of this assembly as it is an easy way to dispense culture medium rapidly. It is not necessary that the culture medium be delivered with great accuracy: anything from 10-11 ml is acceptable.

3. Give the culture medium to an instructor for sterilization in the autoclave.

4. Discard any remaining culture medium after preparing the 25 tubes of medium.

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent-Plant 2 Lab. No. 52

Station 6 Collection Date 4/12 Time 10:00 A~~P~~M

Received in Laboratory 10:20 A~~P~~M Test Started 10:30 A~~P~~M

By HLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a	+		+	
	b	+		+	
	c	−			
	d	−			
	e	+		−	
0.01	1a	−			
	1b	−			
	1c	+		+	
	1d	−	+	−	
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ______

12-30

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 4 Lab. No. 53

Station 4 Collection Date 1/12 Time 9:45 A/PM

Received in Laboratory 10:20 A/PM Test Started 10:30 A/PM

By HLS

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	−	+	−	
	b	−	−		
	c	+		+	
	d	−	+	−	
	e	−	−		
0.1	a	−	+	−	
	b	−	−		
	c	−	−		
	d	−	−		
	e	−	−		
0.01	1a	−	−		
	1b	−	−		
	1c	−	−		
	1d	−	−		
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Efflunt-Plant 16 Lab. No. 54

Station 3 Collection Date 1/12 Time 9:30 A/PM

Received in Laboratory 10:20 A/PM Test Started 10:30 A/PM

By HLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a/	+		+	
	b/	+		+	
	c/	+		+	
	d/	+		−	
	e/	+		+	
0.01	1a	+			
	1b	−	+	−	
	1c	−	+	−	
	1d	+		+	
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ____

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent-Plant 22 Lab. No. 55

Station 4 Collection Date 1/12 Time 9:15 A~~P~~M

Received in Laboratory 10:20 A~~P~~M Test Started 10:30 A~~P~~M

By HLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a/	+		+	
	b/	+		+	
	c/	+		+	
	d/	—	—		
	e/	+		+	
0.01	1a	+		+	
	1b	+		—	
	1c	+		+	
	1d	—	—		
	1e	—	+	—	
0.001	2a	—			
	2b	—	+	+	
	2c	+			
	2d	—	+	—	
	2e	+		—	

Code of Positive Tubes: - - MPN Index _____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 2 Lab. No. 56

Station 6 Collection Date 1/14/74 Time 9:40 A~~P~~M

Received in Laboratory 11:00 A~~P~~M Test Started 11:05 A~~P~~M

By

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a	–	–		
	b	–	+	–	
	c	–	+	–	
	d	–	–		
	e	–	+	–	
0.1	a	–	–		
	b	–	–		
	c	–	+	–	
	d	–	–		
	e	–	–		
0.01	1a	–	–		
	1b	–	–		
	1c	–	–		
	1d	–	–		
	1e	–	–		
0.001	2a	–	–		
	2b	–	–		
	2c	–	–		
	2d	–	–		
	2e	–	–		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 1 Lab. No. 57
Station 4 Collection Date 1/14/94 Time 9:50 A~~P~~M
Received in Laboratory 11:00 A~~P~~M Test Started 11:10 A~~P~~M
By

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a	+		−	
	b	−	+	−	
	c	+		−	
	d	−	−		
	e	−	−		
0.1	a	−	−		
	b	+		+	
	c	−	+	−	
	d	−	−		
	e	−	−		
0.01	1a	−	−		
	1b	−	−		
	1c	−	−		
	1d	−	−		
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Block 16 Lab. No. 5-8
Station 3 Collection Date 1/19/74 Time 10:20 A~~P~~M
Received in Laboratory 11:00 A~~P~~M Test Started 11:15 A~~P~~M
By

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.01	1a	−	−		
	1b	−	−		
	1c	+		+	
	1d	−	−		
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____
Fecal Coliforms: ____/100 ml Reported by: ______

12-36

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 32 Lab. No. 59

Station 4 Collection Date 1/11/77 Time 10:00 A~~P~~M

Received in Laboratory 11:00 A~~P~~M Test Started 11:20 A~~P~~M

By

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+			
	b	+			
	c	+			
	d	+			
	e	+			
0.1	a	+			
	b	+			
	c	+			
	d	+			
	e	+			
0.01	1a	+		+	
	1b	+		+	
	1c	+		+	
	1d	+		+	
	1e	+		+	
0.001	2a	+		+	
	2b	+		+	
	2c	+		+	
	2d	+		+	
	2e	+		+	

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ____

Summary Record of Student Performance on MPN Tests

NAME OF ANALYST	Sample Number	No. of Tubes Positive					MPN Index	MPN/100 ml	Log MPN
		1.0 ml	0.1 ml	0.01 ml	0.001 ml	0.0001 ml			
Total of logs									
Mean of logs									
Antilog of mean of logs (geometric mean)									

Name ______________________

LABORATORY RESULTS

SAMPLE	pH RESULTS
Sample 1	
Sample 2	
Sample 3	
Sample 4	
Buffer 9	

INSTRUCTIONAL QUIZ

for the

pH Determination of Wastewater and Wastewater Treatment Plant Effluents

SELECT ONE ANSWER

1. The selection of the pH scale (0-14) is based on the:
   a. solubility of ions in water.
   b. formation of hydroxyl ions in solution.
   c. ionization constant for water.

2. The pH concept was proposed by Sorenson (1909). Instead of expressing hydrogen ion concentration in terms of molar concentrations he suggested:
   a. expression of such values in terms of their negative logarithms.
   b. expression of such values in terms of their dissociation solubilities.
   c. expression of such values on a scale from 0-14 units.

3. A pH meter:
   a. measures electrical potential between two suitable electrodes.
   b. determines conductance of acids and bases.
   c. relates temperature to ion concentrations of aqueous solutions.

4. The indicating electrode always:
   a. assumes a potential dependent on the pH of the solution.
   b. contains saturated potassium chloride solution.
   c. contains a glass membrane which is semi-permeable to aqueous solutions.

5. The mechanism by which the glass membrane responds to hydrogen ion activity involves:
   a. absorption of hydrogen ions on both sides of the membrane.
   b. semi-permeability of the glass membrane for aqueous solutions.
   c. electrical conductance of the solution.

6. The reference chamber of the pH electrode system should always be kept nearly full with saturated potassium chloride solution because:

   a. the potential must be constant (+ 0.246 volt).
   b. battery life is prolonged.
   c. the electrode is less likely to be damaged.

7. The pH sensitive glass membrane dehydrates when removed from water and thus it is imperative that dry electrodes be soaked in:

   a. buffer or water for several hours before use.
   b. dilute acid to activate the electrode.
   c. dilute base to activate the electrode.

8. In using a pH meter the instrument should be calibrated:

   a. in the general range of the unknown solutions. Appropriate buffers can be selected (pH 4.0, 6.8, 7.4 and 10.0).
   b. in air.
   c. in the laboratory.

9. Standard pH solutions can be most economically prepared by the use of:

   a. formulas outlined in standard methods.
   b. commercially available powder pillows.
   c. commercially available pH standard solutions.

10. Results obtained with pH meters are limited in accuracy to:

   a. 0.1 pH unit.
   b. 0.01 pH unit.
   c. 0.001 pH unit.

Typical Laboratory Data Sheet
for
TOTAL SUSPENDED (NON-FILTERABLE) SOLIDS, mg/liter

Name of Plant ______________________________

STEP	SUSPENDED SOLIDS	SAMPLE	SAMPLE	SAMPLE	
B.2	Identification			INS #1	1
B.2	Type (grab, etc.)			GRAB	2
B.2	Date & Time Collected			5/1/74 0900	3
B.2	Sample Collector			Tom Sampler	4
C.4	Filter Identification			WG2	5
E.1	Date & Time Analysis began			5/1/74 1100	6
E.8	ml Sample Filtered			67.0	7
H.6	1st weight of Filter* plus Residue (g)			0.1426	8
I.10	2nd weight of Filter* plus Residue (g)			0.1416	9
I.13	Difference (1st-2nd)			0.0010	10
I.14	3rd weight of Filter* plus Residue (g)			0.0413	11
I.14	Difference (2nd-3rd)			0.0003	12
I.14	Final weight of Filter* plus Residue (g)			0.1413	13
C.7	Weight of Filter* (g)			0.1293	14
K.3	Find Difference (g) by subtracting Line 14 from Line 13			0.0120	15
K.5	Divide to 7 decimal places: $\frac{\text{(line 15) difference (g)}}{\text{(line 7) ml sample filtered}}$			0.0001791	16
K.7	Multiply Line 16 by 1000 000 (move decimal point 6 places Rt.)			179.1	17
K.9	Round answer on Line 17 to nearest whole number			179 mg/l	18
I.15	Analyst			Mary Analyst	19

*"Filter" means the filter disc if a funnel type filtration assembly is used. If Gooch crucibles are used "filter" means the crucible containing a filter disc.

PART II - INSTRUCTIONAL PACKAGE WORKSHEETS

For each Effluent Monitoring Procedure (commonly termed "EMP" by Instructors) in the Student Reference Manual, there is an Instructional Package Worksheet (IPW) in this Guide. The Worksheet is for guidance to the Instructor for development of the subject matter covered in the course.

These Worksheets are not scripts. The Instructor will need to make extensive and detailed preparation in order to perform the assigned tasks effectively and efficiently. The Instructional Packages do provide a perspective on the background of each analytical procedure, lesson-by-lesson learning achievement levels the students should attain, an indication of available audiovisual and other instructional resources, and a recommended course of action in pre-course preparation and classroom/laboratory instruction.

Application of these Instructional Packages will help the Instructor to reduce the time required for planning and organizing a strategy of preparation and instruction. But time and effort are required for physical preparations for classroom and laboratory instruction; time and effort are required for rehearsals of Instructor performance in classroom and laboratory. These requirements never can be met by such a Course Guide as this; ultimately the Instructor is the key person in assuring that the student acquires the needed knowledge and skills.

Part II. Instructional Package Worksheets

A. BOD and Related Procedures

1. FR stipulates the method described in Standard Methods, 14th ed., p. 543. No different BOD method is presented either by ASTM or in the EPA Methods Manual.

2. The method permits dissolved oxygen determination either by the (Alsterberg) modified Winkler method, or by means of a DO probe.

3. In order to permit flexibility in application of this test in various treatment works, this course provides for DO determination both by the modified Winkler method and by a probe method. Two variants on the probe method are available, one based on a Weston and Stack DO probe, and the other based on a Yellow Springs Instrument.

4. This multiplicity of EMP's based on differences in instrumentation will not be practiced regularly. It is included here to demonstrate the need for modifying existing "EMP's" when the local situation requires use of a different make and model of instrumentation than shown in the EMP provided in the model course.

5. Under stipulated conditions, a permit-holder may be allowed to substitute the COD test for the BOD determination. It is recommended that those wishing to make this substitution consult with their own regulatory agency before making such a change. In any case, it is recommended that the COD test be taught in another course, and not substituted for the BOD test in this course.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

DETERMINATION OF FIVE-DAY BIOCHEMICAL OXYGEN DEMAND (BOD_5)

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

CH.O.bod.IPW.2c.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Determination of Five-Day Biochemical Oxygen Demand, BOD_5

UNIT OF INSTRUCTION:

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 2-1/2 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should know how to perform the Biochemical Oxygen Demand Test because it is required by the permit system.

ENTRY LEVEL BEHAVIOR: The learner must have 1) the same entry level behavior listed in EMP, CH.0.EMP.1c.7.77, Winkler Determination of Dissolved Oxygen-Azide Modification, and 2) successfully completed the effluent monitoring procedure (EMP) mentioned in 1).

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will exhibit proper technique while determining the five-day biochemical oxygen demand of a sample.
2. Conditions - The learner will have the use of the EMP and the equipment and reagents listed in sections D. and E. of this instructional package worksheet.
3. Accepted Performance - The use of proper technique in performing the test will be judged by the instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:
   a. XT54, Slide/Tape Unit "Determination of the Biochemical Oxygen Demand."
   b. TC-40, Color Videocassette "Sample Dilution."
   c. OT-2, Overhead Transparencies (14).
2. Suggested Media: None

C. INSTRUCTIONAL APPROACH (SEQUENCING):

Note to Instructor: The dissolved oxygen content of the samples/blanks prepared using this EMP will be determined using a dissolved oxygen meter or the Azide modification of the Winkler procedure. See the appropriate EMP's and instructional package worksheets (IPW's).

1. Classroom
   a. Discuss the five-day biochemical oxygen demand test (BOD_5) using XT-54 or OT-2.

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C. INSTRUCTIONAL APPROACH (SEQUENCING) (Continued)

b. Point out that the two dissolved oxygen determinations (initial and final) will be made on the samples and blanks prepared by the learners using the EMP, but that a dissolved oxygen measurement could also be made (for instructional purposes) on an "artificial" sample such as distilled water.

c. Show TC-40.

d. Make the sample assignments; i.e., tell the learners what % dilutions of the effluent they will be making. (The instructor will need to have this information prior to the start of the course; i.e., what dilutions will give an acceptable oxygen depletion over the incubation period.)

e. Point out that a four-day BOD will be done (assuming the test is started on Monday and completed on Friday). Note also that this is alright for instructional purposes, but that a full five day incubation period is to be used for reporting purposes. Mention also that it is not acceptable to apply a factor to a four-day BOD result to obtain a BOD_5.

f. Tell the learners what method they will be using to make the dissolved oxygen determinations; i.e., Winkler procedure - Azide modification, or a dissolved oxygen meter. Use the appropriate EMP and IPW.

2. Laboratory

a. Have the learners do sections/steps B.6.1., B.6.2, C.1., C.2., C.3., C.4.1., and C.4.2. on pages 9, 10, and 11 of the EMP.

3. Classroom

a. Resolve any problems which may have arisen during the laboratory session.

b. Point out that the final dissolved oxygen determination will be made using the same method as for the initial determination.

4. Laboratory

a. After four days, have the learners do the final dissolved oxygen determination on the samples/blanks.

5. Classroom

a. Have the learners do section D. on pages 11 and 12 of the EMP.

b. Final discussion/questions.

D. IPW EQUIPMENT REQUIREMENTS:

Note to Instructor: Several of the items in sections D. and E. needed to perform the actual dissolved oxygen determination are also listed in the appropriate IPW; i.e., the Winkler procedure - Azide modification, or the dissolved oxygen meter.

For each learner:

1. Laboratory apron.
2. Safety glasses.
3. One distilled water plastic squeeze bottle.

D. IPW EQUIPMENT REQUIREMENTS (Continued)

For each learner:

4. One pen or pencil.
5. One notebook (for recording data).
6. One 2 liter graduated cylinder.
7. One 1 liter graduated cylinder.
8. One 100 ml graduated cylinder.
9. Four 2 ml volumetric pipets.
10. One pipet bulb.
11. One plunger type mixer (for use with the 1 liter graduated cylinder).
12. Four 300 ml (± 3 ml) BOD bottles (see pages 16 and 17 of the EMP).
13. One siphon (long enough for use with the 2 liter graduated cylinder).
14. Equipment for doing the dissolved oxygen measurement. See the appropriate IPW; i.e., the Winkler procedure - Azide modification, or the dissolved oxygen meter.

For the class as a whole:

1. Still, or other source of distilled water.
2. Incubator, capable of maintaining a temperature of 20°C ± 1°C, and holding the BOD bottles for the entire class.

E. IPW REAGENT REQUIREMENTS:

1. Prior to the start of the class, the instructor will have prepared solutions B.2. through B.5.

Solution	Approx. ml. needed per learner per sample
B.2.	2
B.3.	2
B.4.	2
B.5.	2

2. Also, the instructor will have prepared all solutions needed to determine dissolved oxygen by the Azide modification of the Winkler procedure, or by a dissolved oxygen meter. See the appropriate IPW's.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

WINKLER DETERMINATION OF DISSOLVED OXYGEN-AZIDE MODIFICATION

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

CH.O.IPW.2b.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Winkler Determination of Dissolved Oxygen-Azide Modification

UNIT OF INSTRUCTION:

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 2-1/2 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should know how to perform a dissolved oxygen test since it is an integral part of the five day biochemical oxygen demand test which is required by the permit system.

ENTRY LEVEL BEHAVIOR: The learner must be able to:

1. Perform basic mathematical computations (addition, subtraction, multiplication and division).
2. Handle solutions of acids and bases safely.
3. Boil water on a hot-plate safely.
4. Understand the terms liter, milliliter, gram, milligram.
5. Understand the term normality, to the extent that it is a chemical way of expressing concentration.
6. Perform weighings on an analytical and on a trip balance.
7. Use ordinary laboratory glassware such as beakers, flasks, graduated cylinders, volumetric flasks, burettes, volumetric and graduated pipettes.
8. Clean laboratory glassware.
9. Prepare chemical solutions.
10. Prepare a desiccator for use.
11. Perform a titration (the emphasis should be on proper technique, rather than on the type of titration).
12. Use a Kemmer sampler and an APHA sampler.

NOTE: These 12 skills may be obtained by successful completion of Course 164.6, Self-Monitoring Procedures: Basic Laboratory Skills.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will exhibit proper technique while determining the oxygen content of a sample of distilled water, or, the sample may be one prepared for use in determining the five-day biochemical oxygen demand (BOD_5).

2. Conditions - The learner will have the use of the EMP and the equipment and reagents listed in sections D. and E. of this instructional package worksheet.

3. Accepted Performance - The use of proper technique in performing the test will be judged by the instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:
   a. XT29, Slide/Tape Unit "Determination of Dissolved Oxygen".
   b. TC-38, Color Videocassette "Titration of Sample"; TC-39, Color Videocassette "Standardization of Sodium Thiosulfate".
   c. OT-1, Overhead Transparencies - 6.

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B. INSTRUCTIONAL RESOURCES (Continued)

2. Suggested Media:

None.

C. INSTRUCTIONAL APPROACH (SEQUENCING):

Note to Instructor: If the DO topic is to be taught independently of BOD_5, then use distilled water for the sample as indicated in A.1. above. If it is to be taught as part of the BOD_5 topic, then samples would be those prepared in the effluent monitoring procedure, Determination of Five-Day Biochemical Oxygen Demand (BOD_5).

1. Classroom
   - a. Discuss the importance of the test using OT-1.
   - b. Point out that this procedure may stand along; e.g., the sample may, or may not, be one prepared for the determination of BOD_5.
   - c. Explain why the sodium thiosulfate pentahydrate, $Na_2S_2O_3.5H_2O$, must be standardized at the time of use.
   - d. Explain the concept of a primary standard solution, potassium biiodate, $KH(IO_3)_2$, in this determination.
   - e. Show TC-39. Mention that the color changes which take place during the standardization also occur during the titration of the sample.
2. Laboratory
   - a. Have the learners do section C. on pages 10 and 11 of the effluent monitoring procedure (EMP).
3. Classroom
   - a. Resolve any problems which may have arisen during the laboratory session.
   - b. Show TC-38. Point out whether the sample which will be titrated is an "artificial" sample such as distilled water, or one which will be used as part of a BOD_5 test. XT-29 may be used in place of TC-38, but it contains some information which does not directly pertain to the actual sample titration.
4. Laboratory
   - a. Have the learners do sections D.2., D.3., and D.4. on pages 11, 12, 13, and 14 of the EMP.
   - b. If the sample is to be distilled water, the instructor should have one BOD bottle of distilled water for each learner. (Its approximate oxygen content may be determined by shaking a large supply of distilled water, not so vigorously shaken as to super supersaturate the water however, siphoning or pouring the water slowly into the BOD bottles, taking the temperature of the water, and finding the corresponding dissolved oxygen value on pages 446 and 447 of the 14th Standard Methods.)
   - c. If the sample is to be one which is part of a BOD_5 determination, then it will be prepared by the students. (See section C. of the IPW for BOD_5.)

C. INSTRUCTIONAL APPROACH (SEQUENCING) (Continued)

5. Classroom
   a. Resolve any problems which may have arisen during the laboratory session.

D. IPW EQUIPMENT REQUIREMENTS:

For each learner:

1. Laboratory apron.
2. Safety glasses.
3. One pen or pencil.
4. One notebook (for recording data).
5. One 25 ml buret.
6. One ring stand.
7. One buret clamp.
8. One distilled water plastic squeeze bottle.
9. One spatula (medium size).
10. One 500 ml wide mouth Erlenmeyer flask.
11. One plastic weighing boat (2-3 inches square).
12. One 10 ml graduated cylinder.
13. One 100 ml graduated cylinder.
14. One 20 ml volumetric pipet.
15. Three 5 ml graduated pipets.

For the class as a whole:

1. Still, or other source of distilled water.
2. Three trip balances, 100 g capacity.

E. IPW REAGENT REQUIREMENTS:

For each learner:

1. Three g potassium iodide, KI.
2. Prior to the start of the course, the instructor will have prepared solutions B.1. through B.7.

Solution	Approx. ml. needed per learner per each dissolved oxygen determination or sodium thiosulfate standardization
B.1.	2
B.2.	2
B.3.	2
B.4.	0 (This is a stock solution which is diluted before use)
B.5.	8
B.6.	20
B.7.	10

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

DECHLORINATION OF SAMPLES FOR BIOCHEMICAL OXYGEN DEMAND AND SEEDING OF THE DILUTION WATER

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

CH.O.bod.IPW.2.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Dechlorination of Samples for Biochemical Oxygen Demand and Seeding of the Dilution Water

UNIT OF INSTRUCTION:

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 3 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The biochemical oxygen demand test is required by the NPDES permit system. Chlorine added to wastewater treatment plant effluents for disinfection purposes, and the resulting chlorine compounds, which are formed are interferences in the test. Biochemical oxygen demand samples must therefore be dechlorinated prior to running the test, if the results are to be meaningful.

ENTRY LEVEL BEHAVIOR: The learner must be able to:

1. Perform basic mathematical computations (addition, subtraction, multiplication and division).
2. Handle solutions of acids and bases safely.
3. Boil water on a hot-plate safely.
4. Understand the terms liter, milliliter, gram, milligram.
5. Understand the term normality, to the extent that it is a chemical way of expressing concentration.
6. Perform weighings on an analytical and on a trip balance.
7. Use ordinary laboratory glassware such as beakers, flasks, graduated cylinders, volumetric flasks, burettes, volumetric and graduated pipettes.
8. Clean laboratory glassware.
9. Prepare chemical solutions.
10. Prepare a desiccator for use.
11. Perform a titration (the emphasis should be on proper technique, rather than on the type of titration).
12. Use a mortar and pestle.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will exhibit proper technique while dechlorinating a sample of wastewater treatment plant effluent, while checking for completeness of dechlorination, and while seeding a supply of dilution water.

2. Conditions - The learner will have the use of the EMP and the equipment and reagents listed in sections D. and E. of this instructional package worksheet.

3. Accepted Performance - The use of proper technique in performing the dechlorination, checking, and seeding will be judged by the instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:

None.

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B. INSTRUCTIONAL RESOURCES (Continued)

2. Suggested Media: a. An XT unit covering the subject matter.

C. INSTRUCTIONAL APPROACH (SEQUENCING):

Note to Instructor: As Course 164.1 (Effluent Monitoring Procedures: Basic Parameters for Municipal Wastewaters) is currently organized, there is insufficient time to present this topic. If you would like to include it, several alternatives are available; e.g., omit one of the other topics, have one evening session, etc. If you do include it, keep in mind that after working through the EMP, the student will have on-hand a BOD_5 sample which has been dechlorinated, and a supply of seeded dilution water at $20^oC \pm 1^oC$. This sequencing will have to be combined with the sequencing in the instructional package worksheets on the Winkler Determination of Dissolved Oxygen-Azide Modification, and the Determination of Five-Day Biochemical Oxygen Demand (BOD_5).

1. Classroom - discussion of chlorine as an interference in the BOD_5 test. Point out that the EMP involves dechlorinating an aliquot of the sample, dechlorinating the entire sample, checking for the completeness of dechlorination, seeding the dilution water, setting up seed controls, and calculating the seed correction to be applied to the BOD_5 value.

2. Laboratory - Have the learners to sections C., D., and E. on pages 13-16 of the EMP.

3. Classroom - Since the laboratory exercise is long and somewhat involved, use this period to answer questions about the procedure sofar, and to review what will be done in sections F.1. and F.2. In connection with F.1.1.1a., it would probably be better, from a learning standpoint, to set up all three seed control dilutions (10, 15, and 20%), rather than relying on your experience to select the one dilution which will give a 40-70% depletion. Also, note that the sample dechlorination and the setting up of the seed controls would be done just prior to beginning the BOD_5 determination, since the seed controls are incubated along with the BOD samples.

4. Laboratory - Have the learners do sections F.1., F.2., and F.3. The final dissolved oxygen determination on the seed controls will, of course, be done at the same time as the final determination is made on the BOD_5 sample.

5. Classroom - Have the learners do sections F. and G. Answer any remaining questions about the procedure.

D. IPW EQUIPMENT REQUIREMENTS:

For each learner:

1. Laboratory apron.
2. Safety glasses.
3. One pen or pencil.
4. One notebook (for recording data).
5. One distilled water plastic squeeze bottle.
6. One pipet bulb.
7. One 25 ml buret.

D. IPW EQUIPMENT REQUIREMENTS (Continued)

For each learner:

8. One small funnel (to fit into the top of the buret).
9. One clamp (to support the buret)
10. One ring stand (for use with the buret and clamp).
11. One magnetic stirrer (optional).
12. One magnetic stirring bar about 1 inch long (optional).
13. Three 1 liter graduated cylinders.
14. One 100 ml graduated cylinders.
15. One 50 ml graduated cylinders.
16. One 10 ml graduated cylinders.
17. One siphon (for use with the 1 liter graduated cylinders).
18. One 100 ml volumetric pipet.
19. One 10 ml graduated pipet.
20. One 500 ml Erlenmeyer flask.
21. Six 300 ml (± 3 ml) BOD bottles.
22. One plunger type mixer.

For the class as a whole:

1. One incubator, 20°C ± 1°C (large enough for 6 BOD bottles per learner).
2. Still, or other source of distilled water.

E. IPW REAGENT REQUIREMENTS:

1. Prior to the start of the course, the instructor will have prepared solutions B.2. through B.6. (In reference to B.6., the dilution water, the instructor will have to calculate how much 20°C distilled water to have on hand. A maximum of 300 ml per BOD bottle will be needed.)

2. The instructor will also have collected seed material and incubated it at 20°C ± 1°C for 24-36 hours. (see B.1.).

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

DETERMINATION OF DISSOLVED OXYGEN USING A DISSOLVED OXYGEN METER

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

CH.O.do.IPW.2b.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Determination of Dissolved Oxygen Using a Dissolved Oxygen Meter

UNIT OF INSTRUCTION:

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 1-1/2 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should know how to perform a dissolved oxygen measurement since it is part of the five-day biochemical oxygen demand test which is required by the permit system.

ENTRY LEVEL OF BEHAVIOR: The learner must have 1) the same entry level behavior listed in EMP, CH.O.EMP.1c.7.77, Winkler Determination of Dissolved Oxygen-Azide Modification, and 2) successfully completed the EMP mentioned in 1).

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior: The learner will exhibit proper technique while placing the Weston and Stack Model 300 Dissolved Oxygen Meter into operation and using it to make a dissolved oxygen measurement.

2. Conditions: The learner will have the use of the EMP, and the reagents and equipment listed in sections D. and E. of this instructional package worksheet.

3. Accepted Performance: The use of proper technique in placing the meter into operation and using it to make a measurement will be judged by the instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:

   a. TC-41, Parts I and II, Color Videocassette showing sequence of placing meter into operation.

   b. X-6, Slides, unassembled - 28. Shows all parts of the Weston-Stack Model 300 D.O. Meter.

2. Suggested Media: None

C. INSTRUCTIONAL APPROACH (SEQUENCING):

Note to the Instructor: If the meter is to be used to make the initial and final dissolved oxygen measurements for the BOD_5, then this IPW would be used along with the EMP and IPW on BOD_5. An "artificial" sample such as distilled water could also be used as a sample just to show how the meter works.

1. Classroom

   a. Discussion of dissolved oxygen meters as an alternate way of measuring dissolved oxygen using X-6.

   b. Show TC-41, Parts I and II.

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C. INSTRUCTIONAL APPROACH (SEQUENCING) (Continued)

2. Laboratory
    a. Have the learners do section C. on pages 11 through 20 of the EMP.
    b. Resolve any problems which may have arisen during the laboratory session.

D. IPW EQUIPMENT REQUIREMENTS:

Shared (number of learners to be determined by the instructor)

1. Weston & Stack Model 300 Dissolved Oxygen (DO) meter with Model A-30 Probe, accessory kit and manufacturer's instruction book.
2. One small blade screwdriver.
3. One rubber band.
4. Paper towels.
5. Silicone lubricant.
6. Still, or other source of distilled water.
7. One 1 inch long piece of scotch tape.
8. One 5 ml syringe or eyedropper with tapered end.
9. Small pocket knife.
10. One 300 ml BOD bottle. (More bottles may be used depending on what the sample is; i.e., an "artificial" sample such as distilled water or samples/blanks for a BOD_5 determination.)
11. Equipment needed for performing the DO determination is listed in the effluent monitoring procedure, Winkler Determination of Dissolved Oxygen-Azide Modification.

E. IPW REAGENT REQUIREMENTS:

Shared (same number as determined for D. above).

1. Prior to the start of the course, the instructor will have prepared solutions B.1., B.2., and B.3., and the solutions in sections B.1. through B.7. of the EMP on the Winkler Determination of Dissolved Oxygen-Azide Modification.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

pH DETERMINATION OF WASTEWATER AND WASTEWATER TREATMENT PLANT EFFLUENTS

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATER

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. ENVIRONMENTAL PROTECTION AGENCY

CH.pH.IPW.2a.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: pH Determination

UNIT OF INSTRUCTION: pH Determination of Wastewater and Wastewater Treatment Plant Effluents

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 2 hours

JUSTIFICATION FOR THIS OBJECTIVE: The learner should know how to set up, calibrate, and use a pH meter for the pH determination of wastewater and wastewater treatment plant effluents.

ENTRY LEVEL BEHAVIOR:

A. Instructional Objective

1. Terminal Behavior - The learner will determine the pH of several standard solutions and typical samples of treatment plant effluents.

2. Conditions - The learner will have the use of the attached CH.pH.EMP.1.9.73 and all chemicals and equipment listed in it.

3. Accepted Performance - Acceptable technique in performing the test will be determined by the instructor.

B. Instructional Resources

1. Available Media - XT-69, Slide/Tape Unit "pH Meter - Lab Operation." OT-11, Overhead Transparencies - 7.
2. Suggested Media -

C. Instructional Approach (Sequencing)

1. Discussion of the various types of available pH meters by the instructor.

2. Distribution of pre-instructional quiz to all participants.

3. Discussion of the operation of a pH meter by the instructor.

4. Showing of A/V unit XT-69 pH Determination of Wastewater and Wastewater treatment plant effluents.

5. Laboratory exercise involving set up, calibration, and use of pH meter. Learner will use two prepared buffer solutions for calibration and will determine the pH of two prepared buffer solutions and three typical samples of treatment plant effluents.

6. Critique of the laboratory exercise by the instructor.

7. Distribution of post instructional quiz to all participants.

8. Review and grading of pre and post quizzes.

Supplement to
Guidelines for Instructional
Package Worksheet

pH Determination of Wastewater and Wastewater Treatment Plant Effluents

OBJECTIVE: This narrative provides the basic procedures for setting up pH equipment for the instructional sequence pH Determination of Wastewater and Wastewater Treatment Plant Effluents. Methods for the preparation of buffer and sample solutions used in the sequence are also described.

EQUIPMENT SET-UP: pH instrumentation for the sequence should be set up as follows:

1. All pH equipment should be set up in operation according to the specific instrument manufacturer's instructions at least 48 hours prior to use in the course.
2. The pH meters should be tested for accuracy and reliability by following the procedure in the EMP for calibration and use of the instrument for pH measurement.
3. Batteries used in portable pH meters must be new or recently checked with a volt meter to insure they meet required voltage specifications.
4. Follow the step-wise procedure (D) Maintenance in the EMP to insure that the level of saturated potassium chloride is sufficient in the electrode.
5. If erratic needle movement is noticed, check procedure (E) Trouble Shooting in the EMP. If the trouble cannot be corrected, replace electrode with new one.
6. Periodically use the pH meter for the measurement of the pH of a known standard at least twice a day prior to the course.

BUFFER PREPARATION: Buffer solutions can be prepared according to the formulation provided in the EMP. A few crystals of thymol should be added per liter of prepared buffer solution to prevent bacterial growth. An analytical balance, capable of measuring to the third decimal place, is required. In the event an analytical balance is not available, commercially prepared pH packets may be substituted.

SAMPLE PREPARATION: Treatment plant effluent samples are preferred for use in the laboratory. If they are not available or are inconvenient to obtain, mixtures of buffer solutions may be used as unknowns.

Name ______________________

LABORATORY RESULTS

SAMPLE	pH RESULT
Sample 1	
Sample 2	
Sample 3	
Buffer 4	
Buffer 9	

INSTRUCTIONAL QUIZ

for the

pH Determination of Wastewater and Wastewater Treatment Plant Effluents

SELECT ONE ANSWER

1. The selection of the pH scale (0-14) is based on the:

   a. solubility of ions in water.
   b. formation of hydroxyl ions in solution.
   [✓ c.] ionization constant for water.

2. The pH concept was proposed by Sorenson (1909). Instead of expressing hydrogen ion concentration in terms of molar concentrations he suggested:

   [✓ a.] expression of such values in terms of their nagative logarithms.
   b. expression of such values in terms of their dissociation solubilities.
   c. expression of such values on a scale from 0-14 units.

3. A pH meter:

   [✓ a.] measures electrical potential between two suitable electrodes.
   b. determines conductance of acids and bases.
   c. relates temperature to ion concentrations of aqueous solutions.

4. The indicating electrode always:

   [✓ a.] assumes a potential dependent on the pH of the solution.
   b. contains saturated potassium chloride solution.
   c. contains a glass membrane which is semi-permeable to aqueous solutions.

5. The mechanism by which the glass membrane responds to hydrogen ion activity involves:

   [✓ a.] absorption of hydrogen ions on both sides of the membrane.
   b. semi-permeability of the glass membrane for aqueous solutions.
   c. electrical conductance of the solution.

6. The reference chamber of the pH electrode system should always be kept nearly full with saturated potassium chloride solution because:

   [✓ a.] the potential must be constant (+ 0.246 volt).
   b. battery life is prolonged.
   c. the electrode is less likely to be damaged.

7. The pH sensitive glass membrane dehydrates when removed from water and thus it is imperative that dry electrodes be soaked in:

   [✓ a.] buffer or water for several hours before use.
   b. dilute acid to activate the electrode.
   c. dilute base to activate the electrode.

8. In using a pH meter the instrument should be calibrated:

[✓ a.] in the general range of the unknown solutions.
Appropriate buffers can be selected (pH 4.0, 6.8, 7.4 and 10.0).
b. in air.
c. in the laboratory.

9. Standard pH solutions can be most economically prepared by the use of:

[✓ a.] formulas outlined in standard methods.
b. commercially available powder pillows.
c. commercially available pH standard solutions.

10. Results obtained with pH meters are limited in accuracy to:

[✓ a.] 0.1 pH units.
b. 0.01 pH unit.
c. 0.001 pH unit.

Part II. Instructional Package Worksheets

C. Microbiology

1. It is important for the instructor to be aware of State requirements concerning bacteriological methods desirable for reporting purposes. Such a requirement, for instance, could dictate the choice of the MPN test method instead of the MF test method for the course given to personnel operating within that State.

2. The Federal Register issuance in force offers two methods for the fecal coliform determination. Both are found in Standard Methods for the Examination of Water and Wastewater (14th Edition) and are:

   a. p. 922 - Fecal Coliform MPN Procedure
   b. p. 937 - Fecal Coliform MF Procedure

   Both of these methods currently carry equal status for applicability, but the method used must be stated in the test reports.

3. Special permit conditions may specify use of the total coliform tests or the fecal streptococcus tests. The instructor should be familiar with these test procedures for discussion purposes.

4. This course does not lend itself to instruction in both the MPN and the MF method simultaneously. Methodology involves so much attention to detail for both procedures that in the time allocated, it is most unlikely that students will be able to meet instructional objectives for both procedures.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

COLLECTION AND HANDLING OF BACTERIOLOGICAL SAMPLES FROM A WASTEWATER TREATMENT FACILITY

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. Environmental Protection Agency

W.BA.sa.IPW.2a.9.77

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Collection and Handling of Bacteriological Samples from a Wastewater Treatment Facility

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 30 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: In his own working environment the student must apply the correct methods for collecting and handling a sample for fecal coliform (bacteriological) testing. Failure to apply correct sampling procedures results in unacceptable data.

ENTRY LEVEL BEHAVIOR: Admission to this course.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior: The student will be familiar with the procedures to be used from any approved sampling point in the wastewater treatment plant, and with accepted procedures for handling samples until start of test.

2. Conditions: Classroom; lecture and conference

3. Accepted Performance: Attendance and participation in this session will be accepted as evidence of familiarity with the procedures and precautions applied to this subject matter.

B. INSTRUCTIONAL RESOURCES

1. Available Media: X-11, Slides, unassembled - 6.

C. INSTRUCTIONAL APPROACH

1. Lecture on "Collection and Handling" principles (allow 15 minutes)

2. Discuss and orient the class to the use of the Effluent Monitoring Procedure in the student reference manual. (allow 5 minutes)

3. Question-and-answer session. In absence of questions raised by class, instructor should pose several questions to the class as necessary to stimulate questions relating to the subject matter and its application to specific in-plant situations and as related to various systems for effluent analyses.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

FECAL COLIFORM TEST

by the

MULTIPLE DILUTION TUBE METHOD

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

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GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Summary of Instruction on Subject Matter

LESSON NUMBER: total 10

ESTIMATED TIME: 7:30

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Fecal coliform test is accepted (required for large plants) among the mandatory tests for municipal wastewater treatment plant effluents under the NPDES Permit System.

ENTRY LEVEL BEHAVIOR: General Educational Development at high-school graduate level (hereafter referred to as GED): ability to operate steam pressure sterilizer; ability to use laboratory balance in range to 50 grams, accuracy ± 0.1 gram; ability to use mouth pipette for sample delivery; ability to transfer liquid cultures with inoculation loop. Successful completion of course "Basic Laboratory Skills for Municipal Treatment Plant Personnel" is acceptable.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will prepare representative bacteriological culture media for MPN Fecal Coliform test; perform all laboratory procedures and record-keeping operations in testing treatment plant effluent samples, and report fecal coliform counts per 100 ml of sample in range 20-1,600,000.

2. Conditions - Classroom instruction and laboratory application. Trainee will be provided with laboratory equipment and supplies designated in EMP "Fecal Coliform Test (MPN)." Samples will be collected by staff.

3. Accepted Performance - As stipulated in individual lessons. This will range from acceptable scores in written (open-book) quizzes, homework written assignments, approval of instructor for laboratory techniques and intermediate points in test procedures; and final results within a designated limit of central tendency of overall class results.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test (MPN): "Standard Methods for the Examination of Water and Wastewater"; "Current Practices in Water Microbiology", available from NTIS (p.9-2); pertinent issuances from Federal Register. Numerous NTOTC Overhead Transparencies.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional objective

1. Lessons 1-6 (incl) on second day of course	(4 hours)
2. Lesson 7 on third day of course (afternoon)	(1.5 hours)
3. Lesson 8-9 on fourth day of course (afternoon)	(1.5 hours)
4. Lesson 10 on fifth day of course (afternoon)	(30 minutes)

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Overview of Test

LESSON NUMBER: 1 of 10

ESTIMATED TIME: 1 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: To orient the trainee on (1) the bacteriological testing requirements associated with the NPDES permit system; and (2) on the overall nature of the fecal coliform (MPN) test.

ENTRY LEVEL BEHAVIOR: Admission to course. See Overview Sheet, page 19-3.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will (1) identify the characteristics of the fecal coliform group which are used to differentiate them from the total coliform group; (2) identify the major steps in the fecal coliform MPN test; and (3) demonstrate familiarity with terms associated with the test procedure.

2. Conditions - Classroom: quiz (open book, written, multiple choice, matching, completion).

3. Accepted Performance - 90% correct score (recommend 80% if quiz is closed book)

B. INSTRUCTIONAL RESOURCES

1. Available Media - Publications noted in cover sheet this subject; EMP "Fecal Coliform Test (MPN)." OT-3, Overhead Transparencies available on loan from NTOTC.

2. Suggested Media - Assemble standardized series of transparencies. Make new ones as required.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Pre-lesson preparation:
   Be sure to have a supply of test #1 on hand. Test provided here (note sample with answers on pages following) is suggested. Sample (without answers marked) is in the section on secretarial preparations.

2. Lecture/conference:
   a. Present NPDES testing requirements as per Federal Register
   b. Fecal coliform criteria under permit system
   c. Orient the class to use of this EMP
   d. Outline fecal coliform test; special reference to pages 2, 5, EMP
   e. Define and explain all pertinent terms.

3. Quiz (open book)
   a. Administer the quiz
   b. Grade and review
   c. Collect for analysis of progress

TEST #1 Name John Smith

EMP: FECAL COLIFORM TEST

Instructions: Place an X in the spaces ( ) which correctly apply to the statements made. Unless otherwise instructed, this is an "open book" quiz. Example: The author(s) of the procedure used here for testing for fecal coliforms is/are:

(x) Rocco Russomanno
( ) Audrey Donahue
( ) Charles Feldmann
(x) Harold Jeter

1. The test procedures described in this body of instruction may be variously known as the

( ) Standard Plate Count Method
(X) Multiple Dilution Tube Method
(X) Most Probable Number Method
( ) Membrane Filter Method
(X) MPN Method

2. The purpose of the fecal coliform test is to determine whether

( ) The effluent from the wastewater treatment plant contains pathogenic (disease-causing) bacteria

(X) The bacteriological quality of the effluent meets requirements set for the plant by the State or other authorities

( ) The water is safe to drink

( ) The effluent water should be recycled through the treatment plant for further reduction of bacteria.

3. To perform the fecal coliform test, measured sample portions are first delivered into

(X) Lactose Lauryl Sulfate Tryptose Broth
( ) EC Broth
( ) Water Bath Incubator
( ) 35°C Air Incubator

4. Lactose Lauryl Sulfate Tryptose Broth may be abbreviated as

( ) EC
(X) LST
( ) BGLB
(X) LLSTB

5. EC Broth may be identified in abbreviated form as

(X) EC
( ) LST
( ) BGEC
( ) LLSTB

6. After 24 hours, incubation in the first medium, the cultures are examined, and a "+" result reported if --

( ) growth occurred in the tubes
(X) gas was present in the tubes
( ) gas was absent in the tubes
( ) fecal coliforms were present

7. Transfers are made from --

(X) tubes showing gas in the first medium --
( ) tubes not showing gas in the first medium --
to -- ( ) Lactose Lauryl Sulfate Tryptose Broth
( ) Eosin Methylene Blue Agar
(X) EC Broth
( ) Brilliant Green Lactose Bile Broth

8. After inoculation of the sample into the first culture medium and incubator, the results are "negative" if --

( ) growth has not occurred within 24 hours
( ) gas has not appeared within 24 hours
(X) gas has not appeared within 48 hours
( ) gas has not appeared within 72 hours

9. After transfer from the first medium, the results are declared "positive" on the second medium if --

( ) gas has appeared within 1 hour
( ) growth has appeared within 24 hours
(X) gas has appeared within 24 hours
( ) gas has appeared within 48 hours

10. Incubation of the tubes in the first medium is --

(X) in an air incubator set at 35°C ± 0.5°C
( ) in an air incubator set at 44.5°C ± 0.2°C
( ) in a water bath incubator set at 37°C ± 0.5°C
( ) in a water bath incubator set at 44.5°C ± 0.2°C

11. Once the sample has been inoculated into the first culture medium, the test for fecal coliform bacteria may require up to

( ) 1 hour
( ) 24 hours
( ) 48 hours
(X) 72 hours
( ) 96 hours

NOTE TO INSTRUCTOR:

1. Score 2 points off for each wrong answer.

2. Note that there are 48 blanks ( ). Some will be correct if left blank ( ), and others must be marked (X) to be correct.

3. This gives each student 4 "free" points.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Equipment and Supply Requirements

LESSON NUMBER: 2 of 10

ESTIMATED TIME: 1 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: In his own working environment the trainee will need to recognize, provide first-line operation and maintenance, and reorder (or request purchase of) replacement equipment and supplies used in the test.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 1, this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will (1) identify equipment and supplies used in the fecal coliform test (MPN); (2) identify specifications of equipment and supplies required; and (3) recognize the operational requirements of the equipment used in the test.

2. Conditions - Classroom; written quiz (open book); multiple choice, matching completion.

3. Accepted Performance - 90% correct score (80% if quiz is closed book)

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test (MPN)". TC-12, color videocassette

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Pre-lesson preparation:
   Be sure to have a supply of test #2 on hand. Test provided here (note sample with answers on pages following) is suggested. Sample (without answers marked) is in the section on secretarial preparations.

2. Lecture/demonstration
   a. Draw attention to EMP "Fecal Coliform Test" (MPN) pp 2,3; A. 1-11
   b. Use CCTV cassette to show and tell items in detail
   c. Discuss any omissions in CCTV cassette; answer questions

3. Be sure to discuss quantity/size requirements associated with testing programs under minimum permit requirements.

4. Quiz: give quiz; grade and review; collect for analysis of progress.

TEST #2 Name Robert Jones

EMP: FECAL COLIFORM TEST

1. The waterbath incubator is to be operated at

   ( ) 35°C ± 0.5°C
   ( ) 35°C ± 0.2°C
   ( ) 44.5°C ± 0.5°C
   (X) 44.5°C ± 0.2°C

2. The air incubator is to be operated at

   (X) 35°C ± 0.5°C
   ( ) 35°C ± 0.2°C
   ( ) 44.5°C ± 0.5°C
   ( ) 44.5°C ± 0.2°C

3. The autoclave is acceptable for

   (X) sterilization of culture media
   (X) sterilization of used cultures
   (X) sterilization of dry glassware
   ( ) preparation of distilled water

4. The autoclave is operated at

   ( ) 35°C
   ( ) 44.5°C
   (X) 121°C
   ( ) 170°C - 180°C

5. Disinfectant solution is used

   ( ) to rinse the hands after working with cultures
   (X) to wash the laboratory bench at the beginning of each day's work
   ( ) to sterilize used cultures before draining the tubes for washing of the glassware
   (X) to wash the laboratory bench at the end of each day's work.

6. Fermentation tube assemblies

( ) are used to prepare sample dilutions
(X) are used to contain culture media to demonstrate gas production from special culture media
(X) consist of a large culture tube with a cap and an inner, smaller, inverted glass tube
(X) must be assembled from different components which are ordered separately
( ) are purchased as complete assemblies.

7. Pipettes --

( ) are used to transfer a culture from one medium to another
(X) are used to deliver a measured sample portion into a culture medium
( ) may be made of glass, copper, or plastic
( ) are sterilized in disinfecting solution
( ) do not have to be sterilized for use in the bacteriology laboratory.

8. In deciding how large an incubator to buy, it is best to select

( ) the largest and most expensive one that the laboratory budget will permit.
( ) one which has shelf space enough to accept the number of racks of new cultures to be inoculated on any given day.
(X) one which has shelf space enough to accept about three times the number of racks of new cultures to be inoculated on any given day.

9. The inoculation loop --

( ) is used to inoculate a sample into the first culture medium in the fecal coliform test
(X) is used to transfer a culture from one culture medium to another
(X) should be made of 26 B and S gauge wire
( ) should be 4 - 5 mm in diameter
( ) may be made of any kind of wire, such as copper, platinum, nichrome, or iron.

NOTE TO INSTRUCTOR:

Score 2-1/2 points off for each wrong answer. (Some blanks correctly will be left blank, while others will be marked with "X" for correct answer).

There are 38 blanks. This scoring system gives each student 5 "free" points.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Media Preparation

LESSON NUMBER: 3 of 10

ESTIMATED TIME: 1 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: In his own working environment the trainee will be responsible for media preparation for this test.

ENTRY LEVEL BEHAVIOR: GED. Ability to use balance, weighing up to 50 grams with accuracy within 0.1 gram; ability to measure distilled water with 1-liter graduated cylinder; ability to operate autoclave.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will prepare 30 tubes of EC Broth, using commercially available dehydrated medium. Based on knowledge and experience gained in this objective it is expected that the trainee will be able to prepare any other liquid media required for total coliform testing.

2. Conditions - Laboratory: Application.

3. Accepted Performance - Approval of instructor: prior to sterilization all tubes of media should contain 10-11 of medium, instructor must become familiar with approximate depth of medium in tube in order to recognize acceptable amount. (This does not require measurement for check.)

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test (MPN)". TC-12 Color Videocassette.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Pre-lesson preparations: Have on hand, either at student-pair working positions or at a conveniently accessible location in the laboratory the following:
   a. Student assignment sheets on media preparation.
   b. 1 culture-tube rack per student.
   c. 4-6 balances, 0.1 gram sensitivity at load 150 grams.
   d. Autoclave
   e. 1 beaker per student, 400-600 ml capacity
   f. Culture tubes with fermentation vials, caps; 25 per student.
   g. 1 10-ml pipet per student
   h. 1 500-ml graduated cylinder per student pair
   i. 5 liters of distilled water
   j. 4-6 1/4-lb bottles of dehydrated EC Broth
   k. Funnel assembly with length of rubber tubing, pinchclamp, ringstand; 1 per student pair.
   l. 1 sponge and disinfectant per student pair.

2. Briefing. Show visual aid demonstration of procedures for lessons 3, 4, 5.
3. Instructor assigns each class member responsibility for media preparation.
4. Trainees prepare medium in accordance with instructions in EMP, A.13
5. Students secure instructor approval of product; turn medium over to instructor. Sterilization will be done by staff member; medium is retained for class use on next two days.
6. Trainees proceed to lesson 4, this series.

EMP - Fecal Coliform (MPN)

Lesson 3

ASSIGNMENT: Same to all students

1. Prepare 300 ml of EC Broth

2. Dispense the medium in 10-ml increments into the 25 fermentation tube assemblies prepared in lesson 4.

3. a. Use a 10-ml pipette for about half of the tubes.

   b. For the remainder of the tubes, use a funnel-with-pinchcock assembly which the staff will have prepared for your use. Make a note of this assembly as it is an easy way to dispense culture medium rapidly. It is not necessary that the culture medium be delivered with great accuracy: anything from 10-11 ml is acceptable.

3. Give the culture medium to an instructor for sterilization in the autoclave.

4. Discard any remaining culture medium after preparing the 25 tubes of medium.

SPECIAL NOTE TO INSTRUCTOR:

Note that the preparation of 300 ml of culture medium will require an adjustment of the amount of dehydrated medium described in the EMP. Making this adjustment will be a useful part of the learning experience of the students in the course.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Preparation of Laboratory Data Sheet

LESSON NUMBER: 4 of 10

ESTIMATED TIME: 30 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Trainees will have to prepare a laboratory data sheet ("bench sheet") for every sample tested in their own facilities; or to use some form of collective record. Day-by-day records essential to performance of this test.

ENTRY LEVEL BEHAVIOR: Completion of first three less of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Given detailed sample source information and sensitivity range for the test, trainee will prepare laboratory data sheet for sample to be tested for fecal coliform count.
2. Conditions - Laboratory: application.
3. Accepted Performance - Approval of instructor. Planned sample volumes must span the pre-testing information given about the sensitivity range of the test to be performed.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test MPN". OT3, overhead transparency. TC-12, Color videocassette, part 2.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Pre-lesson preparation: Have available in the classroom 2 copies per student of the data sheet. Sample as it might appear after completion by student is on the following page. The basic format of this sample is found in the secretarial preparations section. It may be necessary to use a different data format in some States for compliance with mandatory forms used by the State in which the course is conducted.
2. Provide preliminary briefing to class (See C., lesson 3)
   a. Draw attention to EMP, B.3., 1.2.3
   b. Show visual aids to illustrate preparation of data sheet.
   c. Provide background data to class for use in preparing data sheet.
3. Trainees prepare their individual data sheets.
4. Instructor inspects data sheets; approves or calls for corrections.
5. Upon satisfactory completion of data sheet, trainee proceeds to lesson 5, this series.

NOTE: Each student will prepare two sample data sheets. One will be turned in daily for inspection.

(SAMPLE)

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Outfall - Final Effluent Lab. No. 14

Station 4 Collection Date 9/15 Time 10:30 A~~P~~M

Received in Laboratory 10:40 A~~P~~M Test Started 10:45 A~~P~~M

By R. Smith

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a				
	b				
	c				
	d				
	e				
0.1	a				
	b				
	c				
	d				
	e				
0.001	1a				
	1b				
	1c				
	1d				
	1e				
0.001	2a				
	2b				
	2c				
	2d				
	2e				

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ___/100 ml Reported by: _____

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Assembly and labeling of culture tubes

LESSON NUMBER: 5 of 10

ESTIMATED TIME: 30 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is an essential feature of test performance; requires absolutely accurate sample identification and identification of individual tubes in the test series.

ENTRY LEVEL BEHAVIOR: Acceptable completion of lesson 4 of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Given an accepted data sheet for a sample to be tested, trainee will assemble requisite number of tubes of lactose lauryl sulfate tryptose broth in a rack in a designated organization, and will label each tube in accordance with a code prescribed by the instructional staff.
2. Conditions - Laboratory: application.
3. Accepted Performance - Approval of instructor; tubes to be organized in rows as specified by instructor; labeled in accordance with code established for the use of the class.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test MPN." TC-12, Color Videocassette, pt 3.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Pre-lesson preparation: Have available, either at student work positions or at a well-organized table in the laboratory the following:
   a. 1 culture tube rack per student
   b. 20 tubes single-strength lactose lauryl sulfate tryptose fermentation broth per student.
   c. 1 wax pencil
2. Briefing of class (See C. Lesson 5)
   a. Draw attention to EMP's Item B.4, 5
   b. Instruct class to proceed in accordance with instructions shown there and in Section VII.
   c. Draw attention to sample display chart of tube labeling.
3. Class to label tubes
4. Instructor to approve
5. After all of class has finished lesson up to 5 of this series, go to class briefing for lesson 6.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Sample Inoculation and Associated Procedures

LESSON NUMBER: 6 of 10

ESTIMATED TIME: 1 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is the essential first-stage of the test-proper. It must be performed by the analyst.

ENTRY LEVEL BEHAVIOR: GED; Satisfactory completion of lessons 1-5, this series. Ability to use pipette for inoculation of bacteriological culture media.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will correctly inoculate sample portions into primary inoculation medium in volumes specified in the data sheet prepared in lesson 6, this series.
2. Conditions - Laboratory: application.
3. Accepted Performance - Approval of instructor.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test MPN". TC-12, Color Videocassette, part 4

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective

1. Pre-lesson preparation: Have available, either at student work positions or at a well-organized table in the laboratory, the following:
   a. Sample of "sewage treatment plant effluent," prepared as follows:
      (1) Collect fresh municipal sewage from a main or from influent into a wastewater treatment plant, not less than 3 hours before class time. Refrigerate until class time; as class begins --
      (2) Deliver 0.3 ml of the sewage into 2 liters of sterile dilution water contained in a 4-liter bottle;
      (3) Shake thoroughly, and
      (4) Deliver into individual sample containers, one per student, labeled with typical information required of a sample.
   b. 2-3 1-ml pipets, sterile, per student
   c. Pipet disposal jar, per student pair
   d. 1-2 99-ml dilution water blanks per student
   e. 1 sponge and disinfectant solution.

2. Briefing
    a. Show audiovisual
    b. Draw attention to EMP B.6.7.8.9, covering assignment of this lesson.
3. Distribute samples to class.
4. Class performs steps outlined in EMP B.6,7,8,9.
5. Instructor circulates in class constantly, correcting errors as noted.
6. Trainees to place cultures in incubator.
7. End of day's activity in coliform tests.
8. Continue with lesson 7 after 24 = 2 hours incubation.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: 24-hour procedures associated with the test

LESSON NUMBER: 7 of 10

ESTIMATED TIME: 1.5 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is an essential part of the test sequence. It must be performed on a scheduled basis if the trainee is to perform a bona fide sample test.

ENTRY LEVEL BEHAVIOR: GED. Satisfactory completion of lessons 1-6 of this series. Ability to use inoculation loop in making transfers of liquid cultures.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will perform the steps outlined in EMP "Fecal Coliform Test" (MPN), C.1,2,3,4,5,6 inclusive.
2. Conditions - Laboratory: application. Preliminary briefing in classroom.
3. Accepted Performance - Approval of instructor. Instructor to circulate in class; observe and check reading of 24-hour results, recording of results, transfers to EC Broth. Correct deficiencies on the spot. All 24-hour positive results should fall into the same order of magnitude (not varying by more than ± 3 tubes from a "norm."

B. INSTRUCTIONAL RESOURCES

1. Available Media - OT-3, overhead transparencies, unassembled. TC-13, Color Videocassette, part 1.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Have available at each class working position:
   a. Gas burner
   b. Inoculation loops, at least 1, preferably 2
   c. Discard basket for cultures
   d. Sponge and disinfectant
   e. Supply of EC broth prepared by students on previous day, and sterilized by staff.
2. Class briefing
   a. Draw attention to EMP, C1,2,3,4,5,6. Instruct class to perform steps.
   b. Demonstrate procedures, preferably with CCTV cassette.
3. Class to perform laboratory procedures identified in A.1 above.
4. Instructor to circulate in class; observe, consult, correct deficiencies.
5. Continue with lesson 8 after 24 ± 2 hours incubation.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: 48-hour procedures associated with the test.

LESSON NUMBER: 8 of 10

ESTIMATED TIME: 30 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is an essential part of the test. It must be performed 48 hours after initial sample inoculation if a bona-fide test is to be performed.

ENTRY LEVEL BEHAVIOR: GED; Satisfactory completion lessons 1-7 of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will perform the steps outlined in EMP "Fecal Coliform Test" (MPN) D.1-6, inclusive.
2. Conditions - Preliminary briefing in classroom; laboratory; application.
3. Accepted Performance - Approval of instructor. Instructor to circulate in laboratory; special attention to reading and recording of results; proper disposition of discarded cultures. Correct deficiencies on the spon.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test MPN". TC-13, color videocassette, part 2.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Set up student working positions with discard baskets, inoculation loops, EC broth, sponge, and disinfectant.
2. Class briefing
    a. Draw attention to EMP D.1-6, inclusive. Instruct class to perform steps.
    b. Demonstrate procedures, preferably with CCTV cassette. Secondarily use tape-slide sequence.
3. Class to perform laboratory procedures identified in A.1 above.
4. Instructor to circulate in class; observe, consult, correct deficiencies.
5. Continue with lesson 9 after 24 ± 2 hours incubation.

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 2 Lab. No. 52

Station 6 Collection Date 1/12/74 Time 10:00 A~~P~~M

Received in Laboratory 10:30 A~~P~~M Test Started 10:30 A~~P~~M

By H L Jeter

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a	+		+	
	b	+		+	
	c	−			
	d	−			
	e	+		−	
0.01	1a	−			
	1b	−			
	1c	+		+	
	1d	−	+	−	
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index _____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source *Effluent - Plant 4* Lab. No. *53*

Station *4* Collection Date *1/12/74* Time *9:45* A~~P~~M

Received in Laboratory *10:20* A~~P~~M Test Started *10:30* A~~P~~M

By *HLJ*

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	−	+	−	
	b	−	−		
	c	+		+	
	d	−	+	−	
	e	−	−		
0.1	a	−	+	−	
	b	−	−		
	c	−	−		
	d	−	−		
	e	−	−		
0.01	1a	−	−		
	1b	−	−		
	1c	−	−		
	1d	−	−		
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	--	−		

Code of Positive Tubes: - - MPN Index _____

Fecal Coliforms: ____/100 ml Reported by: _______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 16 Lab. No. 54

Station 3 Collection Date 1/12/74 Time 9:30 A~~P~~M

Received in Laboratory 10:20 A~~P~~M Test Started 10:30 A~~P~~M

By NLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a	+		+	
	b	+		+	
	c	+		+	
	d	+		−	
	e	+		+	
0.01	1a	+			
	1b	−	+	−	
	1c	−	+	−	
	1d	+		+	
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 22 Lab. No. 55

Station 4 Collection Date 1/12/74 Time 9:15 A~~P~~M

Received in Laboratory 10:20 A~~P~~M Test Started 10:30 A~~P~~M

By H L J

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a	+		+	
	b	+		+	
	c	+		+	
	d	−	−		
	e	+		+	
0.01	1a	+		+	
	1b	+		−	
	1c	+		+	
	1d	−	−		
	1e	−	+	−	
0.001	2a	−			
	2b	−	+	+	
	2c	+			
	2d	−	+	−	
	2e	+		−	

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 2 Lab. No. 56

Station 6 Collection Date 1/11/74 Time 9:40 A~~P~~M

Received in Laboratory 11:00 A~~P~~M Test Started 11:05 A~~P~~M

By HLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	−	−		
	b	−	+	−	
	c	−	+	−	
	d	−	−		
	e	−	+	−	
0.1	a	−	−		
	b	−	−		
	c	−	+		
	d	−	−		
	e	−	−		
0.01	1a	−	−		
	1b	−	−		
	1c	−	−		
	1d	−	−		
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ____/100 ml Reported by: ____

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 4 Lab. No. 57

Station 4 Collection Date 1/17/74 Time 9:50 A~~P~~M

Received in Laboratory 11:00 A~~P~~M Test Started 11:10 A~~P~~M

By TLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a	+		−	
	b	−	+	−	
	c	+		−	
	d	−	−		
	e	−	−		
0.1	a	−	−		
	b	+		+	
	c	−	−		
	d	−	+	−	
	e	−	−		
0.01	1a	−	−		
	1b	−	−		
	1c	−	−		
	1d	−	−		
	1e	−	−		
0.001	2a	−	−		
	2b	−	−		
	2c	−	−		
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index ____

Fecal Coliforms: ___ /100 ml Reported by: ______

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 16 Lab. No. 58

Station 3 Collection Date 1/14/74 Time 10:26 A~~P~~M

Received in Laboratory 11:00 A~~P~~M Test Started 11:15 A~~P~~M

By TJLJ

Remarks

ml sample per tube	tube code	Presumptive LLSTB 24 hr.	Presumptive LLSTB 48 hr.	Fecal ECB 24 hr.	No. Tubes Positive
1.0	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.1	a	+		+	
	b	+		+	
	c	+		+	
	d	+		+	
	e	+		+	
0.01	1a	−	+	−	
	1b	−	−		
	1c	+		+	
	1d	−	−		
	1e	−	−		
0.001	2a	−	+	−	
	2b	−	−		
	2c	−	+	−	
	2d	−	−		
	2e	−	−		

Code of Positive Tubes: - - MPN Index

Fecal Coliforms: ____/100 ml Reported by:

FECAL COLIFORM TEST

Multiple Dilution Tube (MPN) Method

Sample Source Effluent - Plant 22 Lab. No. 59

Station 4 Collection Date 1/14/74 Time 10:00 A~~P~~M

Received in Laboratory 11:00 A~~P~~M Test Started 11:20 A~~P~~M

By ____________

Remarks

ml sample per tube	tube code	Presumptive LLSTB		Fecal ECB	No. Tubes Positive
		24 hr.	48 hr.	24 hr.	
1.0	a	+			
	b	+			
	c	+			
	d	+			
	e	+			
0.1	a	+			
	b	+			
	c	+			
	d	+			
	e	+			
0.01	1a	+		+	
	1b	+		+	
	1c	+		+	
	1d	+		+	
	1e	+		+	
0.001	2a	+		+	
	2b	+		+	
	2c	+		+	
	2d	+		+	
	2e	+		+	

Code of Positive Tubes: - - MPN Index _____

Fecal Coliforms: ____/100 ml Reported by: _______

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Determination of MPN from Completed Data Sheets

LESSON NUMBER: 9 of 10

ESTIMATED TIME: 1 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Analyst is required to report count per 100 ml of sample based on combinations of positive and negative tubes; as essential part of the test procedure.

ENTRY LEVEL BEHAVIOR: GED. Successful completion of lessons 1-8, this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will be able to compute the MPN per 100 ml of sample from tube results tabulated on a data sheet for total coliform test.

2. Conditions - Classroom; application. Trainee will work with simulated data sheets under instructor guidance; based on this instruction the trainee will be able to perform a similar operation on the data sheet for the laboratory application of coliform test.

3. Accepted Performance - Correct evaluation of at least 5 out of 6 data sheets for the following factors: a. number of confirmed tubes positive for each group of 5; b. the correct MPN Code; c. the correct MPN index; and d. the correct MPN per 100 ml.

B. INSTRUCTIONAL RESOURCES

1. Available Media - OT-3, overhead transparencies

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Have available a set of simulated data sheets for student exercise. Sample set is in section on secretarial preparations. Instructor should work out and mark on set of data sheets presented here the correct codes for positive tubes, MPN Index, and MPN per 100 ml. This should be done prior to class.
2. Lecture/demonstration of objectives of converting tube results to numerical results.
3. Show audiovisual unit.
4. Distribute simulated data sheets to class.
5. Work through one simulated data sheet with class "By the numbers."
6. Have individual class members work out the four elements in A.3, above.

7. Review results with class; have class grade simulated data sheets.
8. Collect papers for analysis of progress.
9. Give additional (home) work to trainees not meeting acceptable performance requirements.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test (MPN)

UNIT OF INSTRUCTION: Termination of test: 72 hours

LESSON NUMBER: 10 of 10

ESTIMATED TIME: 30 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: An essential part of test, which must be performed by analyst.

ENTRY LEVEL BEHAVIOR: GED. Satisfactory completion of lessons 1-9, this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will perform the steps outlined in EMP "Fecal Coliform Test" (MPN) E, 1-5; F, 1-6; and G, 1.

2. Conditions - Laboratory: application. Given, the culture which has been under study during the entire sequence of testing, the student will use the basic bacteriological supplies and equipment to terminate the test and report results.

3. Accepted Performance - Approval of instructor. MPN code should be within ± 3 tubes of class "norm." MPN index and MPN per 100 ml should be correct without tolerance for error for the code reported.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test E, F, and G, inclusive. TC-13, color videocassette, parts 3, 4 & 5.

   Suggested Media - Chalkboard, or blank chart; for entry of individual results of class into a composite table of results.

C. INSTRUCTIONAL APPROACH (Sequencing) - Step by step listing of instructional events and/or use of media required to reach the instructional objective.

1. Set up student working positions with discard baskets, inoculation loops, EC broth, sponge, and disinfectant.
2. Class briefing
   a. Draw attention to pertinent portions of EMP
   b. Instruct class to report final MPN Code, Index, and Fecal Coliforms/100 ml on chalkboard or blank chart as provided.
3. Class to perform procedures as assigned.
4. Class to be reconvened at last for final overview and summary of results.
5. Final questions and commentary on test and observations of class performance.

Summary Record of Student Performance on MPN Tests

NAME OF ANALYST	Sample Number	No. of Tubes Positive					MPN Index	MPN/100 ml	Log MPN
		1.0 ml	0.1 ml	0.01 ml	0.001 ml	0.0001 ml			
Total of logs									
Mean of logs									
Antilog of mean of logs (geometric mean)									

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

FECAL COLIFORM TEST BY MEMBRANE FILTER METHOD

as applied in
WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATER

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. ENVIRONMENTAL PROTECTION AGENCY

W.BA.IPW.3a.9.77

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Summary of Instruction on Subject Matter

LESSON NUMBER: total of 8 lessons ESTIMATED TIME: 7:30

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Fecal coliform test is accepted (required for large plants) among the manditory tests for municipal wastewater treatment plant effluents under the NPDES Permit System.

ENTRY LEVEL BEHAVIOR: General Educational Development at high-school graduate level (GED): ability to operate steam pressure sterilizer; ability to use laboratory balance in range to 50 grams, accuracy ± 0.1 gram; ability to use mouth pipette for sample delivery,

or

successful completion of Basic Laboratory Skills for Treatment Plant Operators (BLS-TPO).

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will prepare representative bacteriological culture media for MF fecal coliform test; perform test laboratory procedures and record-keeping operations in testing treatment plant effluent samples, and report fecal coliform counts per 100 ml of sample in range 100-1200.

2. Conditions - Classroom instruction and laboratory application. Trainee will be provided with laboratory equipment and supplies designated in EMP "Fecal Coliform Test (MF)." Samples will be prepared by staff.

3. Accepted Performance - As stipulated in individual lessons. This will range from acceptable scores in written (open book) quizzes, homework written assignments, approval of instructor for laboratory techniques and intermediate points in test procedures; and final results within a designated limit of central tendency for overall class results.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test (MPN); "Standard Methods for the Examination of Water and Wastewater"; "Current Practices in Water Microbiology", available from NTIS (p. 9-2); pertinent issuances from Federal Register. Numerous NTOTC Overhead Transparencies and Slides.

2. Suggested Media - NTC slides and projectuals must be organized in standardized series to be used with designated lessons of this series.

C. INSTRUCTIONAL APPROACH (Sequencing)

1.	Day 2 of course - Lessons 1 - 5 inclusive.	4.5 hours
2.	Day 3 of course - Lessons 6 - 7	1.5 hours
3.	Day 4 of course - Lessons 8 - 9	1.5 hours
	Total	7.5 hours

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Overview of Test

LESSON NUMBER: 1 of 9 ESTIMATED TIME: 1.0 hours

JUSTIFICATION FOR THIS LESSON: In order to meet the basic self-monitoring requirements for municipal wastewater treatment plant effluents, the student needs to have information about (1) the bacteriological testing requirements associated with the NPDES permit system; and (2) on the overall nature of the fecal coliform test using the membrane filter method.

ENTRY LEVEL BEHAVIOR: Admission to training based on (1) successful completion of "Basic Laboratory Skills" course; or through (2) satisfying the training registrar that the individual has adequate prior knowledge and skills to give reasonable assurance of satisfactory completion of this training module.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will (1) identify the characteristics of the fecal coliform group and the characteristics of the total coliform group; (2) identify the major steps in the fecal coliform membrane filter procedure; and (3) demonstrate familiarity with terms associated with the test organism and the laboratory procedure.

2. Conditions - Classroom: quiz (written; may be open book with multiple choice, matching, or completion answers. See example quiz following this instructional package worksheet.

3. Accepted Performance - Suggest requiring 90% correct score if open book quiz, 80% correct score if quiz is closed book.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method. Various slides used in following lessons, available from NTOTC.

C. INSTRUCTIONAL APPROACH

1. a. Before the course: Approximately 30 days before the course, be sure that quiz is composed (if prepared by instructor) or that example quiz is in hands of Course Secretary for reproduction.

   b. Obtain supply of quizzes and review during last week before course.

2. Classroom instruction
   a. Lecture/confererence:
      (1) Present NPDES testing requirements for fecal coliforms as given in Federal Register
      (2) Discuss fecal coliform criteria under permit system
      (3) Orient the class to use of this EMP

(4) Outline the fecal coliform test, with special reference to pages 4 - 5 of the membrane filter procedure in the student reference text.

(5) Define and explain all pertinent terms; answer class questions as they arise.

b. Quiz (recommend open book)

(1) Administer the quiz; allow approximately 15 minutes.

(2) Grade and review the quiz; have students grade their own papers, giving discussions of answers as necessary.

(3) Collect quiz papers for recording of results and for anslysis of student problems/progress.

FECAL COLIFORM TEST (MF)   QUIZ

Lesson 1

Instructions: Place an X in the spaces ( ) which correctly apply to the statements made. Unless otherwise instructed, this is an "open book" quiz.

Example: The author(s) of the procedure used here for testing for fecal coliforms is/are:

(X) Rocco Russomanno
( ) Audrey Donahue
( ) Charles Feldmann
(X) Harold Jeter

1. The purpose of running the fecal coliform test as an effluent monitoring procedure is to:

( ) determine the extent of disease bacteria
( ) correlate it with chemistry analysis
( ) determine effluent quality
( ) indirectly measure chlorination levels

2. The sample water which passes through the membrane filter is:

( ) cultured for a color development
( ) delivered in a series of measured volumes for analysis
( ) used to develop control plates
( ) passed to discard.

3. Fecal coliform colonies are recognized by their:

( ) characteristic size
( ) ability to be seen under magnification of 10X or 15X
( ) blue or blue-tint colorations
( ) ability to continuously give suitable colony densities.

4. Fecal coliform calculations are made:

( ) to give fecal coliforms per 100 ml of sample
( ) based upon the number of blue colonies to blue-tinted colonies as a ratio
( ) based upon the 26 hour reading having subtracted from it the 22-hour count of fecal coliforms
( ) by counting all plates and using all counts for averaging.

5. The flow sheet for the fecal coliform test (MF) indicates:

( ) blue or blue-tinted colonies are viewed before incubation
( ) colonies with blue or blue-tinted colorations must have those without this characteristic subtracted from them
( ) that only a single sample volume is run for results
( ) that immediately after running the sample volumes the fecal coliform colonies can be determined

6. Fecal coliform colonies are counted

( ) by averaging all of the plates
( ) by use of a binocular dissecting scope
( ) at 8-hour intervals
( ) only when the colony centers are blue

Indicate whether the following are True (T) or False (F)

7. Fecal coliforms have an allowable temperature range of 1°C from the desired incubation temperature. ____

8. Plates are incubated in a spray of heated water. ____

9. The count made from each membrane directly gives the count per 100 ml. ____

10. MFC broth is a culture medium. ____

11. Sample water passing through the membrane should have detectable fecal coliforms. ____

12. Fecal coliform plates must be counted at the end of each work day. ____

13. The water bath incubator can vary over several degrees as long as it averages 44.5°C. ____

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Equipment and Supply Requirements

LESSON NUMBER: 2 of 9 ESTIMATED TIME: 0.75 hours

JUSTIFICATION FOR THIS LESSON: In his own working environment the student will need to recognize, provide first-line operation and maintenance, and order (or request purchase of) replacement equipment and supplies used in the test. Furthermore, the student must learn the terminology of the needed equipment and supplies in order to follow instructions and perform procedures outlined in lessons following this.

ENTRY LEVEL BEHAVIOR: Completion of lesson 1 of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will (1) identify equipment and supplies used in the fecal coliform test by membrane filter method; (2) identify specifications of equipment and supplies required; and (3) recognize the operational requirements of the equipment used in the test.

2. Conditions - Classroom: written quiz (open book recommended) using multiple choice, matching, and completion type questions.

3. Accepted Performance - 90% correct score recommended with open book quiz, 80% correct score suggested if quiz is closed book.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by the Membrane Filter Method," pp 6, 7, 8 to the extent readily portable, use the equipment and supplies used in the test. X-12, Slides, unassembled.

C. INSTRUCTIONAL APPROACH

1. Pre-class: Approximately 30 days before the course, be sure that quiz is composed (if prepared by instructor) or that example quiz is in the hands of the Course Secretary for reproduction.

   Obtain the supply of quizzes and review during the last week before the course.

2. Classroom instruction
   (1) Draw attention to EMP "Fecal Coliform Test by Membrane Filter Method," pp 6, 7, 8.
   (2) Discuss all portable equipment and supplies by a "show and tell" method, passing portable equipment through the class; for non-portable equipment, take class to the equipment. Alternately (less desirable) use slides or CCTV cassette (not yet available at writing of this Guide).
   (3) Be sure to discuss quantity/size requirements of equipment and supplies and how they interrelate with the testing requirements with each Permit.

(4) Give the quiz. Have students mark their own papers after writing the quiz; marking of papers to be associated with question-and-answer procedures to clear up any difficulty shown up in quiz. Collect quizzes for recording and for evaluation of student performance and evaluation of instructional efficiency.

Test #2 Name ______________________

EMP: FECAL COLIFORM TEST (Membrane Filter Method)

1. For the fecal coliform test, the waterbath incubator is to be operated at

   ( ) 35°C ± 0.5°C
   ( ) 35°C ± 0.2°C
   ( ) 44.5°C ± 0.5°C
   ( ) 44.5°C ± 0.2°C

2. The autoclave can or should be used for sterilization of
   ( ) Sample bottles
   ( ) Filtration apparatus
   ( ) Dilution water
   ( ) Membrane Filter Culture Media

3. The autoclave is to be operated routinely at

   ( ) 35°C
   ( ) 44.5°C
   ( ) 121°C
   ( ) 170 - 180°C

4. Disinfectant solution is used routinely in the laboratory to

   ( ) rinse the hands after working with cultures
   ( ) wash the laboratory bench at the beginning of each day's work
   ( ) sterilize membrane filter culture medium for use in the lab
   ( ) wash the laboratory bench at the end of each day's work

5. Pipets --

   ( ) Are used to deliver a measured sample portion into the filtration apparatus
   ( ) Are used for preparation of sample dilutions
   ( ) May be made of copper, glass, or plastic
   ( ) Are sterilized in the disinfectant solution prior to use in the bacteriology laboratory
   ( ) Do not have to be sterilized for use in the bacteriology laboratory

6. In deciding how large a water bath incubator to buy, it is best to select --
   ( ) the largest and most expensive one that the laboratory budget will stand
   ( ) one which has enough space to hold the number of cultures to be incubated on the heaviest day's work
   ( ) the one which has space enough to hold the number of cultures to be incubated on an average day's work.

7. The oven sterilizer routinely

( ) is routinely operated in the range 160 to 180°C.
( ) is routinely operated at a temperature of 121°C
( ) is used for sterilization of glass pipets, sample bottles
( ) is used for sterilization of membrane filter culture medium

8. Items which are used repeatedly in the laboratory (pipets, sample bottles, etc)

( ) should be purchased in quantities providing an inventory of at least 3 times the normal single day's requirements
( ) should be purchased in quantities providing an inventory of at least 10 times the normal single day's requirements
( ) should be made of borosilicate glass
( ) may be made of soft glass if used only once then discarded

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Preparation of culture medium

LESSON NUMBER: 3 of 9 ESTIMATED TIME: 1.0 hours

JUSTIFICATION FOR THIS LESSON: In his own working environment the student will be responsible for media preparation and management for this test.

ENTRY LEVEL BEHAVIOR: Basic laboratory skills; ability to use simple balance, graduated cylinder, pipet.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will prepare 50 ml of M-FC broth, commercially available dehydrated medium.

2. Conditions - Laboratory application. Staff will provide dehydrated medium, distilled water, and pre-prepared 1% Rosolic Acid solution in 0.2 N solution of NaOH. Students will sterilize their own media.

3. Accepted Performance - Approval of instructor. Instructor must be thoroughly familiar with appearance of typical satisfactory media, and must be able to recognize visual evidence of omission of such constituents as the rosolic acid solution, or evidence of gross errors in weighing.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method," pp. 14-15. X-13, Slides, unassembled (12).

C. INSTRUCTIONAL APPROACH

1. Before the lesson
   a. Prepare 100 ml of 1% solution of rosolic acid solution in 0.2 N NaOh. This solution is not particularly stable; it may be kept in refrigerator up to one week but is best prepared on day of the lesson.
   b. Have available for student use: balances, dehydrated M-FC broth, empty dilution water bottles, graduated cylinder (50- or 100-ml size), 1-ml pipets, 400-600 ml beakers, electric hot plates.

2. During the lesson
   a. Draw class attention to the EMP procedure on medium preparation cited in B above, pp 14-15. Have class read the procedure.
   b. Demonstrate procedure for weighing, mixing, and sterilizing the medium. Use slides or CCTV material to extent available.
   c. Have class go to laboratory and prepare medium; each student prepares medium for own use for remainder of course. Medium is to be labeled with student's name and stored in refrigerator.
   d. Instructor and instructor's assistant must circulate among class constantly during this laboratory application. Successful attainment of training objective for this subject is heavily dependent upon preparation of an acceptable culture medium.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Preparation of Data Sheet

LESSON NUMBER: 4 of 9 ESTIMATED TIME: 0.5 hours

JUSTIFICATION FOR THIS LESSON: The student will have to prepare a laboratory record sheet ("bench sheet") for every sample tested in his own facilities. Day-by-day records are essential for performance of this test. This lesson provides instruction in application of a useful system of bench records, but does not constitute instruction in a "universal" or required record system.

ENTRY LEVEL BEHAVIOR: Completion of lessons 1 - 3 of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will prepare laboratory data sheet for effluent sample to be tested for fecal coliform content.

2. Conditions - Classroom: application. Student will be given detailed sample source and collection data, and sensitivity range of the test to be performed.

3. Accepted Performance - Approval of instructor. Planned sample volumes must be such that the results will span the expected range of fecal coliform counts predicted under operational conditions.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method," pp 16-17. OT-13, Overhead Transparencies of typical data sheet.

C. INSTRUCTIONAL APPROACH

1. Before the course: Be sure that a supply of student data sheets is prepared. See sample following this worksheet. Blank sample is in section on Secretarial Preparations. Two copies of data sheet per student.

2. During the lesson:
   a. Distribute the data sheets
   b. Show a typical sample, with tagged information on sampling data.
   c. Using projectual (blank) write in the needed information based on sample tag information of a typical sample.
   d. Give students the sample information on the sample they will test; have them prepare two copies of data sheet.
   e. Instructor and instructor-assistant must check each data sheet for correction of any noted errors.

FECAL COLIFORM TEST

Membrane Filter (MF) Procedure

Sample Type______________________ Lab. No.________

Station_______ Description_______________________

Collection Date__________ Time_____ APM. Temp.___

Received ___________ APM. Examined___________ APM.

pH_____________Observations______________________

mls filtered	Colony Count	Remarks

Results:

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Filtration Procedures

LESSON NUMBER: 5 of 9 ESTIMATED TIME: 1.25 hours

JUSTIFICATION FOR THIS LESSON: These procedures are essential to performance of the test. This lesson assumes that fecal coliform counts will be within, or near to, the limits established for compliance with NPDES Permits.

ENTRY LEVEL BEHAVIOR: Basic laboratory skills; use of pipet, graduated cylinder, forceps.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will assemble the needed filtration equipment and supplies at the laboratory bench, and will make a predetermined series of sample volume filtrations through membrane filters, place them in culture containers and incubate according to standardized methodology.

2. Conditions - Laboratory. All equipment and supplies will be available in the laboratory; some will be at the student work positions and some will be organized at side-table support areas. Filtration volumes specified by instructor.

3. Accepted Performance - Approval of instructor.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method," pp 17-21. X-14 Slides, assembled (15) showing step-by-step procedures.

C. INSTRUCTIONAL APPROACH

1. Before the lesson:
   a. Organize student supplies in laboratory. To extent convenient equipment and supplies for each student can be organized at individual work positions. However, instructor should expect to keep at least some of the supply items at side of room where students can get them.
   b. Collect a fresh sewage sample. Dispense 0.3 ml into a 2-liter volume of sterile dilution water in a 4-liter container. Shake vigorously and dispense into individual student sample bottles which are of a type acceptable for standardized sampling. Student samples should be tagged with information corresponding with that provided orally for Lesson 4 of this series. Sewage sample should be collected not more than four hours before class time; dispensing to class sample bottles should be at start of laboratory exercise.

2. During the lesson:
   a. Demonstrate the step-by-step procedures for organizing lab equipment and supplies at work position, preparation of culture containers, labeling of culture containers, sample filtration, and incubation procedures.

This demonstration can be done "live" but is best done with visual aids. Slides illustrating the procedures are available from the National Training Center.

b. Class goes to laboratory, performs sample filtration procedures as described and shown in briefing session.

c. Instructor and instructor-assistant must remain in laboratory throughout this lesson, correcting individual student errors, evaluating performance, answering questions as they arise.

d. Instructor should maintain notes on class performance for entire day's work, in preparation for student evaluation report for the following morning and for course records.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Colony Counting

LESSON NUMBER: 6 of 9 ESTIMATED TIME: 0.75 hours

JUSTIFICATION FOR THIS LESSON: After filtration and incubation, it is essential that fecal coliform colonies be differentiated from other colony types and counted. It is also necessary that the analyst learn to select which of a series of membrane filter preparations be selected for counting.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 5 of this series; use of binocular dissecting microscope.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will remove cultures from incubator, position them under binocular dissecting microscope, provide correct illumination, and will differentiate and count fecal coliform colonies on the membrane filter, entering report of colonies counted on the data sheet.

2. Conditions - Laboratory application following briefing and drill with slides in the classroom.

3. Accepted Performance - Student should obtain at least one membrane filter with fecal coliform colonies present in the range 20 to 60 colonies. Ideally, all students will obtain the above results from the same sample filtration volume.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method." X-15, Slides, unassembled (19). OT-13, overhead transparency of summary report form. (available on loan from NTOTC).

C. INSTRUCTIONAL APPROACH

1. Classroom
   a. Have class read the procedure
   b. Show slides showing acceptable microscope-lighting setup
   c. Show slides with typical, atypical, and non-fecal coliform types; drill class on recognition of various colony types.
   d. To extent available show slides with evidence of common problems or errors--overcrowding, inadequate culture medium, flooding of membrane filter with medium, two or more colonies in contact, effect of fibers on filter.

2. Laboratory
   a. Class members count their own filtrations.
   b. Instructor and instructor-assistant circulates among class constantly, observing results, assisting in interpretations, assuring that microscopes are being used correctly.
   c. Collect one copy of data sheet from each student. Review for indications of similarities or dissimilarities of class results and for student evaluation.
   d. Return data sheet following day for use in lesson 9.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Filtration Procedures

LESSON NUMBER: 7 of 9 ESTIMATED TIME: 0.75 hours

JUSTIFICATION FOR THIS LESSON: When a series of fecal coliform tests yields results higher than the required levels for compliance with the NPDES Permit, it becomes necessary to adjust the filtration volumes in order to secure determinate results.

ENTRY LEVEL BEHAVIOR: Basic laboratory skills; completion of lessons 1 - 3 of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will assemble the needed filtration equipment and supplies at the laboratory bench, and will make a series of sample filtrations through membrane filters, and place them in the incubator.

2. Conditions - Laboratory. All equipment and supplies to be available in room, but not pre-positioned at student work positions. Students will use the M-FC broth they prepared for Lesson 3 of this series. Students will be given a sample which is assumed to have approximately 2000 fecal coliforms per 100 ml, and must determine suitable sample volumes for their tests. Students may obtain approval of instructor for sample volumes selected before proceeding with filtrations.

3. Accepted Performance - Approval of instructor.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "FecalColiform Test by Membrane Filter Method," pp 17-21. Review of X-14 slides if needed.

C. INSTRUCTIONAL APPROACH

1. Before the lesson:
   a. Organize student supplies in laboratory, not at individual work positions in such a way that students can select needed material and organize it effectively at work positions.
   b. Not more than 4 hours prior to lesson, collect a fresh sewage sample. Refrigerate until class time.
   c. At class time, dispense 3.0 ml of the sewage into 2 liters of sterile dilution water in a 4-liter bottle. Shake vigorously.
   d. Dispense into individual student sample bottles, tagged with sample data appropriate to an effluent sample.

2. During the lesson:
    a. Provide student briefing on prior sample data (approximately 2000 fecal coliform/100 ml);
    b. Distribute sample data sheets to students for preparation of laboratory records; (two per student)
    c. Students proceed to laboratory, perform tests as required.
    d. Distribute individual samples to each student-pair at start of laboratory exercise.
    e. Instructor and instructor-assistant must circulate through class, correcting errors, demonstrating proper techniques where needed, answering questions as they arise.

With increasing confidence in their work, students will start to ask questions about collateral issues associated with fecal coliform testing. To extent feasible with laboratory work at hand, instructors should be responsive to any and all questions related to the fecal coliform test requirements and procedures.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Test by Membrane Filter Method

UNIT OF INSTRUCTION: Colony Counting

LESSON NUMBER: 8 of 9 ESTIMATED TIME: 0.75 hours

JUSTIFICATION FOR THIS LESSON: Essential to completion of Lesson 7 of this series

ENTRY LEVEL BEHAVIOR: Completion of Lesson 7 of this series

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will remove membrane filter cultures from Incubator, assemble microscope and lighting equipment, and will count fecal coliform colonies obtained from filtrations in Lesson 7. Counts will be recorded on laboratory record.

2. Conditions - Laboratory

3. Accepted Performance - Each student should obtain at least one membrane filter with fecal coliform colonies present in the range of 20 - 60 colonies. Ideally, all students will obtain acceptable colony density in essentially the same sample filtration volume. In the final analysis, the instructor will have to decide whether the student has performed acceptably, or if further laboratory practice is required.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method" p 21. Review of X-15 slides if needed.

C. INSTRUCTIONAL APPROACH

1. In classroom, have briefing on what is expected for the lesson.
2. Proceed to laboratory, have students work as independently as possible.
3. Instructor and instructor-assistant to remain in laboratory at all times, answering questions, evaluating student performance.
4. After completion of colony counts, return to classroom for Lesson 9.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Fecal Coliform Count by Membrane Filter Method

UNIT OF INSTRUCTION: Determination of Fecal Coliforms per 100 ml

LESSON NUMBER: 9 of 9 ESTIMATED TIME: 0:75 hours

JUSTIFICATION FOR THIS LESSON: Determination of fecal coliform count per 100 ml requires application of a calculation based on sample filtration volumes and numbers of fecal coliform colonies counted in Lessons 6 and 8.

ENTRY LEVEL BEHAVIOR: Ability to solve problems in simple arithmetic; completion of Lessons 6, 8 of this series.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Given the colony counts and sample filtration volumes from Lessons 6 and 8 of this series, the student will select the appropriate membrane filter result(s) for reporting purposes and will calculate fecal coliforms per 100 ml, recording the results in the designated place on the data sheet.

2. Conditions - Classroom. Conference-workshop.

3. Accepted Performance - Correct calculations reported to 2 significant figures.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Fecal Coliform Test by Membrane Filter Method" pp 22, 23, 24. OT-13, overhead transparency of summary report form.

C. INSTRUCTIONAL APPROACH

1. Have students read the instructional reference cited above.
2. Go over typical problems created by instructor.
3. Have students make their own calculations based on their data from Lessons 6 and 8.
4. Have students report their calculations. Get all results for Lesson 6, recording on the projectual while showing on screen. Use wax pencil or water-soluble ink; this will permit use of the projectual repeatedly for future offerings of the course.
5. Analyze and discuss similarities of data; seek to determine reasons for any results which are markedly different from class norm.
6. Have students copy data summary for their own future use, possibly for personal practice in calculation of geometric mean, taught in a separate "EMP"

Summary Record of Student Performance
Membrane Filter Test for Fecal Coliform

Name of Analyst	Sample Volume Filtered, ml	Number of Fecal Coliform Colonies	Sample Volume Filtered, ml	Number of Fecal Coliform Colonies	Sample Volume Filtered, ml	Number of Fecal Coliform Colonies	Fecal Coliforms per 100 ml

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

CALCULATION OF THE GEOMETRIC MEAN OF COLIFORM COUNTS

by the

USE OF LOGARITHMS

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. Environmental Protection Agency

ST.IPW.2a.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Geometric Mean

UNIT OF INSTRUCTION: Summary of Instruction on Subject Matter

LESSON NUMBER: One lesson only

ESTIMATED TIME: Two hours for those who have not had logarithms. Thirty minutes for those who know logarithms.

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should know how to calculate the geometric mean of several fecal coliform counts to satisfy permit system reporting requirements for U.S. EPA Form 3320-1.

ENTRY LEVEL BEHAVIOR: Ability to add a series of numbers and to divide the sum by a positive number.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Trainee will know how to calculate the Geometric Mean when using logarithms.

2. Conditions - Trainee will be provided with the EMP, the only equipment needed since a set of logarithms (page 7-11 and 7-12) are included and all necessary instructions.

3. Accepted Performance - Correct calculations of the Geometric Mean for the three practice problems given on page 7-13 of the EMP. The correct school solutions are given below for the instructors use.

$$\begin{aligned} GM\ (1,\ 4) &= \text{antilog} \left[\frac{\log 1 + \log 4}{2}\right] \\ &= \text{antilog} \left[\frac{0.0 + 0.60206}{2}\right] \\ &= \text{antilog} \left[0.30103\right] \\ &= 2 \end{aligned}$$

$$\begin{aligned} GM\ (1,\ 10,\ 100) &= \text{antilog} \left[\frac{\log 1 + \log 10 + \log 100}{3}\right] \\ &= \text{antilog} \left[\frac{0.0 + 1.0 + 2.0}{3}\right] \\ &= \text{antilog} \left[1\right] \\ &= 10 \end{aligned}$$

$$\begin{aligned} GM\ (10,\ 10,\ 10) &= \text{antilog} \left[\frac{\log 10 + \log 10 + \log 10}{3}\right] \\ &= \text{antilog} \left[\frac{1.0 + 1.0 + 1.0}{3}\right] \\ &= \text{antilog}\ [1.0] \\ &= 10 \end{aligned}$$

Additional problems that can be assigned by the instructor are:

GM (1, 100) = 10

GM (1, 9) = 3

GM (188, 200) = 194

GM (20, 484) = 98

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP "Calculation of the Geometric Mean of Coliform Counts by the use of Logarithms." XT-85 (I, II & III) or XT86 (I, II & III)

2. Showing of A/V unit (in preparation) of the same title. Followed by step by step procedure through the EMP by the instructor at a faster pace than 1 above or via self-instruction.

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Discussion of the need for mastering the procedure

2. Showing of A/V unit or

3. Proceed through all steps in the EMP making sure that the example on page 7-13 is understood.

4. Have the students independently solve the practice problems on page 7-1[illegible].

5. Alternative. Instructor can work in class practice problem GM (1, 4) = 2. Then give one of the additional problems without the answer. Student should get the right answer.

D. SPECIAL INSTRUCTION

1. Sometimes the calculation of the MPN leads to an inequality. For example, one result could be the fecal coliform count is less than 2.0 (written as <2.0). Another result could be the fecal coliform count is greater than or equal to 2400 (written as >2400). The recommended solution is shown by two self explanatory examples.

GM (<2, 18) = less than 6   (<6)

since GM (2, 18) = 6

GM ($\geq$2400, 600) = greater than or equal to 1200   ($\geq$1200)

since GM (2400, 600) = 1200

If any fecal coliform count is zero then the above procedure does not apply since statement 2 on page 7-4 states, "each count is greater than or equal to one". One way of handling this problem is to arbitrarily assign the value of 1 for each zero fecal coliform count and then follow the usual program of action outlined above. As an example: GM (0, 0, 0, 16) = G (1, 1, 1, 16) = 2

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

MEASUREMENT OF FLOW IN AN OPEN CHANNEL BY PARSHALL FLUME

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. ENVIRONMENTAL PROTECTION AGENCY

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Measurement of Flow in an Open Channel by Parshall Flume

UNIT OF INSTRUCTION: Basic Elements

LESSON NUMBER: 1 of 3

ESTIMATED TIME: 3/4 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The student must be familiar with the structure of the flume, its operating principles, and factors influencing its performance.

ENTRY LEVEL BEHAVIOR: Student should be familiar with basic units of volume and length.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Student will be able to identify the parts of a Parshall Flume, explain the principle by which flow can be measured using the flume, and identify factors that can influence the measurement obtained.

2. Conditions - Classroom.

3. Accepted Performance - Satisfactory identifications and explanations as indicated under A-1 above.

B. INSTRUCTIONAL RESOURCES

1. Available Media: EMP "Measurement of Flow in an Open Channel by Parshall Flume;" pre-post quiz on principles of Parshall Flume. OT-6, Overhead transparencies - 6.

2. Suggested Media - Video tape or film clip illustrating changes in flow pattern through flume when going from free-flow to submerged flow conditions. Operating model of channel with flume.

C. INSTRUCTIONAL APPROACH (Sequencing)

Classroom - Pre-quiz

Lecture covering following points

1. Review units of flow
2. Structure of flume
3. Operating principles
4. Factors influencing performance

Post quiz

Discussion of quiz

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Measurement of Flow in an Open Channel by Parshall Flume

UNIT OF INSTRUCTION: Determining Flow: Free-flow conditions

LESSON NUMBER: 2 of 3

ESTIMATED TIME: 1 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is the usual flow condition under which a flume should operate

ENTRY LEVEL BEHAVIOR: Student must have successfully completed lesson 1. Must be able to add, subtact and multiply using whole numbers, fractions, and decimals.

A. INSTRUCTIONAL OBJECTIVE
   1. Terminal Behavior - Student will be able to calculate head and use appropriate tables to determine flow through flume - using either a staff gage or a float gage.

   2. Conditions - Classroom.

   3. Accepted Performance - Must be able to read water level elevation using a staff gage or a float gage. Must score at least 80% on quiz on calculating flow under various conditions.

B. INSTRUCTIONAL RESOURCES
   1. Available Media - EMP

   2. Suggested Media - Staff gage section, float gage, quiz material, operating model of channel with flume

C. INSTRUCTIONAL APPROACH (Sequencing)

Lecture, including demonstration of staff gage section and float gage, illustration of head calculations and use of flume discharge tables

Quiz

Review of Quiz

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Measurement of Flow in an Open Channel by Parshall Flume

UNIT OF INSTRUCTION: Determining Flow: Submerged-flow conditions

LESSON NUMBER: 3 of 3

ESTIMATED TIME: 3/4 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Submerged-flow conditions may sometimes occur in unusual circumstances.

ENTRY LEVEL BEHAVIOR: Student must have successfully completed lessons 1 and 2

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Student will be able to determine flow through a flume when submerged-flow conditions exist.

2. Conditions - Classroom.

3. Accepted Performance - Must be able to calculate appropriate heads and use tabular materials and graphs. Must score at least 80% on quiz.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP

2. Suggested Media - Quiz material. Operating model of channel with flume.

C. INSTRUCTIONAL APPROACH (Sequencing)

Lecture, including illustration of head calculations and use of graphical material to correct free-flow discharge to discharge under submerged-flow conditions

Quiz

Review of Quiz

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

MEASUREMENT OF FLOW IN AN OPEN CHANNEL BY SHARP-CRESTED WEIR

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. ENVIRONMENTAL PROTECTION AGENCY

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Measurement of Flow in an Open Channel by Sharp-Crested Weir

UNIT OF INSTRUCTION: Basic Elements

LESSON NUMBER: 1 of 2

ESTIMATED TIME: 3/4 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Student must be familiar with structure of weirs, operating principles, and factors influencing performance.

ENTRY LEVEL BEHAVIOR: Student should be familiar with basic units of volume and length.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Student will be able to identify types of standard weirs and physical conditions which can affect weir performance.

2. Conditions - Classroom.

3. Accepted Performance - Satisfactory identifications as indicated in A-1 above.

B. INSTRUCTIONAL RESOURCES

1. Available Media: EMP "Measurement of Flow in an Open Channel by Sharp Crested Weif." OT-12, Overhead Transparencies - 5. X-16, Slides (2).
2. Suggested Media - Operating model of channel with changeable weirs. Weir plates. Pre- and -post quiz material.

C. INSTRUCTIONAL APPROACH (Sequencing)

Pre-quiz

Lecture with demonstration of flow over weirs under various conditions using model channel

Post-quiz

Discussion of quiz

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Measurement of Flow in an Open Channel by Sharp-Crested Weir

UNIT OF INSTRUCTION: Measurement of Head and Determination of Flow

LESSON NUMBER: 2 of 2

ESTIMATED TIME: 3/4 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: To calculate flows from observations made at a weir installation.

ENTRY LEVEL BEHAVIOR: Student must have successfully completed Lesson 1, and be able to add, subtract and multiply using whole numbers, fractions, and decimals.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Student will be able to calculate head on a weir and use appropriate weir tables to determine flow

2. Conditions - Classroom.

3. Accepted Performance - Calculation of flow under stipulated conditions with a score of at least 90%.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMP

2. Suggested Media - Operating model of channel with changeable weirs. Quiz material

C. INSTRUCTION APPROACH (Sequencing)

Lecture

Quiz

Discuss Quiz

Part II. Instructional Package Worksheets

E. Total Residual Chlorine

1. Accepted methods cited in the FR Issuance in Outline No. 1 of this manual are:

    a. Iodometric titration method, with starch-iodine end-point, as presented in Standard Methods for the Examination of Water and Wastewater, 14th ed, p. 318, Method 409B.

    b. Iodometric titration method, with amperometric end-point, Standard Methods for the Examination of Water & Wastewater, 14th ed, p. 322, method 409C.

    c. DPD Colorimetric or titrimetric methods, as presented in Standard Methods for the Examination of Water & Wastewater, 14th ed, method 409E. on p. 329, and method 409F. on p. 332.

2. The procedure taught in this course is for the amperometric end-point titration method. A second amperometric end-point titration method is presented in the Student Reference Manual. However, it is to be used for surface waters, or otherwise clean waters, not wastewater effluents. It would, therefore, not ordinarily be taught in this course.

3. In the time available for this course, it is strongly urged that no effort be made to teach all three methods.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

AMPEROMETRIC DETERMINATION OF FREE AND COMBINED RESIDUAL CHLORINE IN WASTEWATER

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
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U.S. ENVIRONMENTAL PROTECTION AGENCY

CH.A.CL.IPW.2a.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chlorine Testing

UNIT OF INSTRUCTION: Amperometric titration of free and combined residual chlorine

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 1-1/2 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should know how to perform an amperometric titration for the determination of free and combined residual chlorine in treatment plant effluents to satisfy permit system analytical requirements.

ENTRY LEVEL BEHAVIOR:

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The learner will determine the free and combined residual chlorine concentration in a treatment plant effluent sample.

2. Conditions - The learner will have the use of the attached CH.A.CL.EMP.3.27.74 and all chemicals and equipment listed in it.

3. Accepted Performance - Acceptable technique in performing the test will be determined by the instructor.

B. INSTRUCTIONAL RESOURCES

1. Available Media - XT37, Tape/Slide Unit "Residual Chlorine & Chlorine Demand." OT-5, Overhead Transparencies - 10.
2. Suggested Media -

C. INSTRUCTIONAL APPROACH (Sequencing)

1. Discussion of the importance of the chlorine determination by the instructor.

2. Showing of A/V unit XT-37 Residual Chlorine and Chlorine Demand.

3. Performance of an amperometric titration for the determination of free and combined residual chlorine in a typical sample in the laboratory using the attached EMP.

4. Critique of the laboratory exercise by the instructor.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

TITRIMETRIC DETERMINATION OF TOTAL RESIDUAL CHLORINE IN WASTEWATER EFFLUENTS

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

CH.HAL.cl.IPW.4.6.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Titrimetric Determination of Total Residual Chlorine in Wastewater Effluents

UNIT OF INSTRUCTION:

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 3 hours

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should know how to determine the total residual chlorine content of a wastewater treatment plant effluent because it is required by the NPDES permit system.

ENTRY LEVEL BEHAVIOR: The learner must be able to:

1. Perform basic mathematical computations (addition, subtraction, multiplication and division).
2. Solve problems involving use of the formula ml x N = ml x N.
3. Handle solutions of acids and bases safely.
4. Boil water on a hot plate safely.
5. Understand the terms liter, milliliter, gram, milligram.
6. Understand the term normality, to the extent that it is a chemical way of expressing concentration.
7. Perform weighings on an analytical and on a trip balance.
8. Use ordinary laboratory glassware such as beakers, flasks, graduated cylinders, volumetric flasks, burettes, volumetric and graduated pipettes.
9. Clean laboratory glassware
10. Prepare chemical solutions.
11. Prepare a desiccator for use.
12. Perform a titration (the emphasis should be on proper technique, rather than on the type of titration).
13. Use a mortar and pestle.
14. Use a pH meter.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will exhibit proper technique while determining the total residual chlorine content of a sample of wastewater treatment plant effluent.

2. Conditions - The learner will have the use of the EMP and the equipment and reagents listed in sections D. and E. of this instructional package worksheet.

3. Accepted Performance - The use of proper technique in performing the test will be judged by the instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media: a. XT-93, Determination of Total Residual Chlorine - Iodometric Titration Method.

2. Suggested Media: None.

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C. INSTRUCTIONAL APPROACH (SEQUENCING):

1. Prior to the start of the course the instructor has prepared the reagents in sections B.1., B.2., B.4., B.5., B.6., B.7. and B.8. In addition, for reagent B.3., the instructor has approximately 5 g. of arsenic trioxide in a weighing bottle (with top) stored in a desiccator. (One bottle per student). Also, 225 ml of chlorinated effluent sample (200 ml are needed per determination) are on hand for each student; the instructor may want the learners to repeat the determination, necessitating having more sample on hand.

2. Classroom - discussion of the purposes of chlorination and the other methods for its determination using XT-93, Determination of Total Residual Chlorine - Iodometric Titration Method.

   Emphasize strongly that arsenic tioxide and phenylarsine oxide are toxic, and what to do if these items are spilled on the skin or work area; i.e., washing with large amounts of water, and wiping with damp tissues. The materials must never be ingested.

   Demonstrate the use of a carbon dioxide lecture bottle. (Since this is an easy-to-learn skill, it can simply be demonstrated at this point rather than considering it an entry level skill.)

3. Laboratory - Have the learners do section B.3. By using glass T's or Y's, rubber tubing and clamps, several learners will be able to work from one lecture bottle of carbon dioxide. Have the learners do section C.

4. Classroom - Since the determination is a long one, it would probably be a good idea to stop and resolve any problems which may have arisen during the lab session. Also, a break for lunch could be given at this time if needed.

5. Laboratory - Have the learners do section D.

6. Classroom - Have the learners do section E., and answer final questions regarding the determination.

D. IPW EQUIPMENT REQUIREMENTS

For each learner:

1. Laboratory apron.
2. Safety glasses.
3. Pen or pencil.
4. Notebook (for recording data).
5. One distilled water plastic squeeze bottle.
6. One weighing bottle with top (about 15 ml capacity) containing the 5 g. of arsenic trioxide.
7. Several tissues.
8. Six inch stirring rod.
9. Sufficient aluminum foil to wrap a 1 liter glass-stoppered bottle.
10. Three 1 liter glass-stoppered bottles.

D. IPW EQUIPMENT REQUIREMENTS (Continued):

For each learner:

11. Five plastic weighing boats (about 2 inches square).
12. One 1 liter volumetric flask.
13. One small powder funnel (to fit into the top of a 1 liter volumetric flask).
14. One small funnel (to fit into the top of the burets).
15. One 50 ml buret.
16. One 5 ml buret.
17. One clamp (to support the buret).
18. One ring stand (for use with the buret and clamp).
19. Magnetic stirrer and 2 inch stirring bar (optional).
20. One 50 ml volumetric pipet.
21. One 10 ml volumetric pipet.
22. One 5 ml volumetric pipet.
23. One 10 ml graduated pipet.
24. One 30 ml beaker.
25. One 500 ml Erlenmeyer flask.
26. One 250 ml Erlenmeyer flask.
27. One 500 ml graduated cylinder.
28. One 250 ml graduated cylinder.
29. One 100 ml graduated cylinder.
30. One 10 ml graduated cylinder.
31. One eyedropper.

Shared

1. Trip balance, 100 g. capacity - 1 per 3 or 4 students.
2. Lecture bottle of carbon dioxide - see C.3., 2nd sentence.
3. Fifteen inches of 6 mm glass tubing.
4. Two feet of tygon tubing (to connect the lecture bottle of carbon dioxide to the 6 mm glass tubing).
5. pH meter (with pH 4 and 7 buffers) - 1 per 3 or 4 students.
6. Several small spatulas (for use when weighing solids).

E. IPW REAGENT REQUIREMENTS

For each learner:

1. 15 g sodium hydroxide, NaOH.
2. 66 g potassium iodide, KI

E. IPW REAGENT REQUIREMENTS (Continued):

For each learner:

3. 13 g resublimed iodine, I_2.

4. About 5 ml concentrated (12 N) hydrochloric acid, HCl.

Shared

The reagents prepared by the instructor prior to the start of the course (B.1., B.2., B.4., and B.5. through B.8.) will be sufficient for about 10 learners.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

For The

DETERMINATION OF TOTAL SUSPENDED (NON-FILTERABLE) SOLIDS, mg/liter

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

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National Training and Operational Technology Center
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CH.SOL.SUS.IPW.2b.7.77

P. Total Suspended (Non-Filterable) Solids, mg/liter

1. The Federal Register (FR) issuance in Outline No. 1 of this Guide lists only one method for this determination: glass fiber filtration with drying at 103-105°C.

2. This method is the one written in the Effluent Monitoring Procedure (EMP) format entitled, "Total Suspended (Non-Filterable) Solids, mg/liter".

3. The reference source for the EMP is 1974 EPA "Methods for Chemical Analyses of Water and Wastes," p. 268. The other FR source for the procedure is:
   a. 14th ed., APHA, "Standard Methods for the Examination of Water and Wastewater," p. 94.

4. The EMP provides a choice of filtering equipment. It has directions for using a membrane filter holder with larger filter discs for influent samples which usually contain large amounts of suspended matter. It also has directions for using a Gooch crucible as a filter holder when processing effluent samples which usually require smaller discs.

5. In the following Instructional Package Worksheet, the lesson plan is for the student to use both types of filtering equipment.

6. Each student is to prepare filter discs and then process one wastewater treatment plant influent sample using membrane filtration equipment and one wastewater treatment plant effluent sample using a Gooch crucible. The IPW equipment requirements are based on this assignment. If you choose a different assignment, adjust quantities accordingly.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Summary of 6 elements - CH.SOL.SUS.EMP

ESTIMATED TIME: 255 minutes excluding 210 minutes for dry-cool periods

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner will be responsible for determining total suspended (non-filterable) solids as mg/liter.

ENTRY LEVEL BEHAVIOR: Learner must know how to weigh to 4 decimal places on an analytical balance, how to measure liquids with a pipet and a graduated cylinder, how to work subtraction problems involving decimals and how to multiply and divide factors in a fraction.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will assemble the required equipment (including 1 Gooch crucible and 1 membrane filter assembly), prepare glass fiber filters, determine and report completely dried, total suspended solids to the nearest mg/liter for an influent and an effluent sample and keep complete records of the sample and test data according to the EMP.

2. Conditions - being provided with classroom instruction, the required equipment, two samples, a copy of CH.SOL.SUS.EMP, two copies of data sheets as on page 16-32 and total working time of 150 minutes.

3. Accepted Performance - His techniques must be satisfactory according to an Instructor's rating and his answers must be the same as an Instructor's answers calculated from the same data.

B. INSTRUCTIONAL RESOURCES:

1. Available Media: a. EPA "Methods for Chemical Analyses of Water and Wastes"; EMP "Total Suspended Solids"; equipment and supplies; copies of data sheet on EMP, page 16-32; and example discs which would be rejected due to irregularities showing up during disc preparation. b. TC-21, Videocassette Tape Unit "Preparing the Filter Disc", Part I, 15 minutes; and "Procedures", Part II, 13 minutes. c. OT-4, Overhead Transparencies - 7, showing: Federal Standards, filtration assembly with divisions of solids, definition of non-filterable solids, procedures listed on EMP, page 16-5, the data sheet on EMP, page 16-32, assignment of volumes to be filtered and calculation formula.

C. INSTRUCTIONAL APPROACH:

The method presented in the Effluent Monitoring Procedure (EMP) is according to the EPA Methods Manual. Two types of filtration assemblies are given in that reference - the membrane filter holder with funnel and the Gooch crucible with adapter.

Accordingly, the EMP procedure is written with information about using both these assemblies and this Instructional Package Worksheet (IPW) contains plans for instructing students in techniques for using both.

There is a second reason for presenting the two filtration assemblies to the student. Current legislation regarding secondary treatment not only specifies a limit for suspended solids concentration in effluents (mean up to 30 mg/l for a 30 day collection period, mean up to 45 mg/l for a 7 day collection period) but it also specifies an 85 percent removal of solids to be calculated by comparing the means of influent and effluent samples from a 30 day collection period. Accordingly, the IPW presents plans for instruction where the student does two suspended solids determinations - one on an influent sample and one on an effluent sample. The results are used later in the Course for instruction on reporting data. To facilitate filtering sample volumes approaching 100 ml, the membrane filter assembly with a larger glass fiber disc is used for the influent sample and the smaller Gooch crucible is used for the effluent sample.

In the student's EMP, the step sequence for the suspended solids procedure is given in the second column. When additional information is required in the third column because of slight stepwise differences in handling the two types of filter holders, notes on the Gooch crucible are given first and then the notes on the membrane filter assembly. The third column also contains additional information on procedural steps which apply regardless of the type of filter holder used. The Instructor should explain this order in the third column of the EMP to the students. When the student is using the membrane filter assembly, he should disregard notes beginning with, "If a Gooch crucible is being used------" and he should use all other notes in the third column. When the student is using a Gooch crucible assembly, he should disregard notes beginning with, "If a membrane filter holder is being used----" and he should use all other notes in the third column.

On the CCTV Tapes, the techniques are demonstrated all the way through using a membrane filter holder, then all the way through using a Gooch crucible assembly. Even if the Instructor chooses to present only one of the assemblies, it is strongly recommended that the CCTV Tapes be used. Since the tasks are the same regardless of the type of filter support used, the student would see the series of tasks twice. He would see that more than one filter assembly can be used. He would also better recognize which notes in the third column of his EMP apply to the filter assembly he is using. The Instructor should explain all this when introducing the tape segments and should tell the student if he will be using just one of the assemblies.

The calculation section of the EMP deals with calculating the mg/liter of suspended solids found in each sample analyzed by the student. The calculation using these mg/liter results for an influent and an effluent sample to determine percent removal is presented on the fifth day of the Course, using the EMP on "Reporting of Self-Monitoring Data".

1. Preparation for Instruction:(to be done before fourth day of Course)
    a. Make an alphabetical list of crucibles to be used along with their weights to nearest 0.1 gram and post by balances.

    b. Have desiccant in usable condition.

c. Prepare (rinse-dry-cool) enough discs to fit membrane filter assemblies and enough Gooch crucibles with discs to supply class. Keep discs that should be rejected to show to class.

d. Obtain influent and effluent samples for class. Determine sample volume to assign for each so dried residue weighs more than 0.0025 grams. Label the samples, including information required on the data sheet (p. 16-32).

e. Use list of equipment in D. (below) to supply laboratory stations for each student.

f. Duplicate two copies for each student of data sheet, EMP p. 16-32

2. Sequencing:

   a. On fourth day of Course:

      1) Lesson one - 65 minutes

      2) Break

      3) Lesson two - 85 minutes

      4) Lunch and/or some other activity during 80 minute (minimum) dry-cool period.

      5) Lesson three - 30 minutes

      6) Some other activity during 35 minutes (minimum) of a 50 minute dry-cool period.

      7) Lesson four - 45 minutes

      8) Lesson five - 15 minutes

   b. On fifth day of Course:

      1) Students turn in two completed data sheets (EMP p. 16-32) at beginning of class day. Check entries and accuracy of calculations. NOTE: The difference on line 10 or 12 must be less than 0.0005g and the difference on line 15 must be greater than 0.0025g. Make any corrections on both sheets--one to be returned to the student and one to be retained for Instructor's evaluation of student and for discussion in lesson six.

      2) Lesson six - 15 minutes

D. IPW EQUIPMENT AND SUPPLY REQUIREMENTS:

(Student prepares 2 filter discs but uses 2 pre-washed and dried discs to process 1 influent sample and 1 effluent sample)

1. For each Student:

1 Apron
1 Cylinder, graduated, 25 or 50 ml
1 Cylinder, graduated, volume equal to or greater than the volumes of sample to be filtered
1 Pair forceps (flat, to transfer disc)
1 Flask, suction, 1000 ml
1 Hose connection with pinch clamp (for vacuum)
1 Gooch crucible (without filter disc) and adapter for mouth of suction flask
1 Membrane filter holder assembly (without filter disc) in stopper for mouth of suction flask
1 Pen, felt tip, marking
1 Pair tongs
1 Wash bottle, squeeze type, for distilled water
1 Watch glass, small, for membrane filter size disc
1 Vacuum source or pump drawing 15 inches of mercury. (Avoid sharing. Add time to lessons 1 and 2 if students must share.)

NOTE: Prior to the course, prepare (rinse-dry-cool) for each student 1 filter disc in a Gooch crucible plus 1 filter disc for membrane filter assembly. Store in desiccator(s) for use in class.

2. Shared:

Boxes of filter discs, glass fiber, without organic binder, Reeve Angel type 934 A or 984 H, Gelman type A, Whatman GF/C or equivalent. Diameters should be large enough so discs will cover openings in the Gooch crucible or the membrane filter assembly to be used. Each student needs 1 of each size.

Balances, analytical, capable of weighing to 0.1 mg under a 200 g load, 1 per 4 students.

Box of small, soft tissues by each balance.

Oven, drying, for use at 103 - 105^{o}C with space for 1 Gooch crucible and 1 small watch glass for each student.

E. IPW REAGENT REQUIREMENTS: (minimum amounts per student)

250 ml distilled water
X ml plant influent sample to yield dried residue weighing at least 0.0025 g.
X ml plant effluent sample to yield dried residue weighing at least 0.0025 g.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Preparing the Filter Disc (CH.SOL.SUS.EMP. Procedure A)

LESSON NUMBER: 1 of 6

ESTIMATED TIME: 65 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: To determine suspended solids in a sample, the learner must wash and dry the glass fiber disc before using it.

ENTRY LEVEL BEHAVIOR: None

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - Learner will wash a membrane filter size disc and a disc in a Gooch crucible according to steps 1 through 17 listed in EMP-A, as stated and/or described in the Information column.

2. Conditions - using both membrane filter holder and Gooch crucible assemblies, given the equipment, the EMP, no assistance and 30 minutes.

3. Accepted Performance - He must accomplish terminal behavior to the satisfaction of an Instructor rating. (Particularly note correct placement of discs on holders, tightening the MF funnel to holder, graduality of applying vacuum to seat the disc, careful technique in transferring the MF filter to a support, and using tissue to wipe off and handle Gooch crucible.)

B. INSTRUCTIONAL RESOURCES:

1. Available Media: a. Copies of EMP; example discs which should be rejected when irregularities show up in this procedure. b. OT-4, Overhead Transparencies - 4, showing Federal Standards, filtration assembly with divisions of solids, definition of non-filterable solids and procedures listed on EMP, p. 16-5. c. TC-21, Videocassette Tape Unit, "Preparing the Filter Disc", Part I, 15 minutes.

C. INSTRUCTIONAL APPROACH (Sequencing):

1. Presentation (35 min.)
   a. Lecture - Introduction
      - Overheads - Standards, Assembly and Terms, Definition
      - EMP, p. 16-4: Overview, Stress weighing-filtration-drying-weighing sequence. Note source of method.
      - Overhead - EMP, p. 16-5, Procedures of test
      - Tell students to use p. 16-5 as a "flow sheet" in laboratory.

b. Assignment - Read from above: A. Instructional Objective,
   1. Terminal Behavior.

c. Assignment - Have students read Procedure A.

d. Introduce and run CCTV cassette, "Preparing the Filter Disc."

e. Demonstration - Show examples of discs which should be rejected.

f. Question Period on material presented.

2. Student Performance and Evaluation (30 min.)
   As stated in Instructional Objective above, by Instructor rating

3. NOTE: Students stop after A. Step 17 "Put disc (on support) into an oven." To avoid a time lag for drying and cooling, Instructor should prepare discs ahead of time for student use in the next lesson on the Procedure.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Initial Weighing, Filtration, First Drying (CH.SOL.SUS.EMP, Procedures B, C, D, E, F, G, and J)

LESSON NUMBER: 2 of 6

ESTIMATED TIME: 85 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner will be responsible for determining suspended solids.

ENTRY LEVEL BEHAVIOR: Learner must know how to weigh to 4 decimal places on an analytical balance, and how to measure liquids with a pipet and a graduated cylinder.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - Learner will weigh a membrane filter size disc and use it to filter an influent sample and will weigh a Gooch crucible with disc and use it to filter an effluent sample, using appropriate assemblies and keeping records according to the steps in EMP Procedures B through G.3e. as stated or described in the Information column.

2. Conditions - Learner will be given the equipment, two samples, the EMP, two copies of a data sheet, no assistance and 55 minutes.

3. Accepted Performance - He must accomplish terminal behavior to the satisfaction of an Instructor rating. (Particularly note correct record-keeping on the lab data sheet, careful techniques when transferring filter discs, correct weighing techniques, correct measuring of the volume of sample to filter, thorough rinsing of sample from graduated cylinder and walls of filter, correct handling of the Gooch crucible, and use of EMP clean-up directions.)

B. INSTRUCTIONAL RESOURCES:

1. Available Media - a. Copies of EMP; 2 copies per student data sheet from EMP, p. 16-32. b. OT-4, Overhead Transparencies - 3, showing procedures listed on EMP, p. 16-5 used in lesson 1; the data sheet on EMP, p. 16-32 and volumes of samples. c. TC-21, Videocassette Tape Unit "Procedures", Part II, 13 minutes.

C. INSTRUCTIONAL APPROACH (SEQUENCING):

1. Presentation - (30 min.)

   a. Lecture - Introduction
      - Overhead - EMP, p. 16-5, Procedures of test
      - Tell students to use p. 16-5 as a "flow sheet" in laboratory. They will use filter discs washed, dried, and cooled before course.

b. Assignment - Read from above: A. Instructional Objective, 1. Terminal Behavior.

c. Assignment - Have students read Procedures B through G.

d. NOTE: In lab, stop after G.3.e. which includes J. Cleaning the Equipment, Step 1.

e. Distribution - Give each student two copies of the data sheet which are to be filled in and given to Instructor at end of EMP work. One will be returned to the student after Instructor checks it. Overhead - Note the organization (sample information - analytical results - calculations) and references to EMP Procedures.

f. Assignment - Overhead - Assign approximate volume of influent sample to be filtered through a membrane filter assembly using Procedures B through G.3a. Then assign approximate volume of effluent sample to be filtered through a Gooch crucible assembly using Procedures B through G.3e. Have students write volumes and assembly to be used at top of their data sheet. Explain that some reports require calculation of per cent removal of suspended solids. In this case, both influent and effluent samples must be tested so they will test both types in this Course.

g. Introduce and run CCTV cassette, "Procedure."

h. Question Period on material presented

2. Student Performance and Evaluation (55 min.) as stated in Instructional Objective above, by Instructor rating.

3. NOTE: Students stop after G step 3 "Put disc (on support) into an oven." To avoid a time lag for drying and cooling, some other student activity should be planned for the next 80 minutes (minimum). Instructor/students should remove crucibles and discs from oven after 60 minutes and put them in desiccators for the 20 minute cooling period.

HAND-OUT for LESSON 2
(2 copies to each student)

Typical Laboratory Data Sheet

for

TOTAL SUSPENDED (NON-FILTERABLE) SOLIDS, mg/liter

Name of Plant ____________________________

STEP	SUSPENDED SOLIDS	SAMPLE	SAMPLE	SAMPLE	
B.2	Identification			INS #1	1
B.2	Type (grab, etc.)			GRAB	2
B.2	Date & Time Collected			5/1/74 0900	3
B.2	Sample Collector			Tom Sampler	4
C.4	Filter Identification			WG2	5
E.1	Date & Time Analysis began			5/1/74 1100	6
E.8	ml Sample Filtered			67.0	7
H.6	1st weight of Filter* plus Residue (g)			0.1426	8
I.11	2nd weight of Filter* plus Residue (g)			0.1416	9
I.14	Difference (1st-2nd)			0.0010	10
I.15	3rd weight of Filter* plus Residue (g)			0.1413	11
I.15	Difference (2nd-3rd)			0.0003	12
I.15	Final weight of Filter* plus Residue (g)			0.1413	13
C.7	Weight of Filter* (g)			0.1293	14
K.3	Find Difference (g) by subtracting Line 14 from Line 13			0.0120	15
K.5	Divide to 7 decimal places: $\frac{\text{(line 15) difference (g)}}{\text{(line 7) ml sample filtered}}$			0.0001791	16
K.7	Multiply Line 16 by 1000 000 (move decimal point 6 places Rt.)			179.1	17
K.9	Round answer on Line 17 to nearest whole number			179 mg/l	18
I.16	Analyst			Mary Analyst	19

*"Filter" means the filter disc if a funnel type filtration assembly is used. If Gooch crucibles are used "filter" means the crucible containing a filter disc.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Weighing the Filter Disc and Residue (CH.SOL.SUS.EMP. Procedure H)

LESSON NUMBER: 3 of 6

ESTIMATED TIME: 30 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is part of the laboratory procedure to determine total suspended (non-filterable) solids, mg/liter.

ENTRY LEVEL BEHAVIOR: Learner must know how to weigh to 4 decimal places on an analytical balance.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior- Learner will weigh the MF disc plus residue and the Gooch crucible with disc plus residue from lesson 2 and record the weights to 4 decimal places according to the steps in EMP Procedure H as stated or described in the Information column.

2. Conditions - Learner will be given the equipment, the EMP, no assistance and 25 minutes.

3. Accepted Performance - Learner will perform Procedure H to the satisfaction of an Instructor rating. (Particularly note correct techniques for handling the Gooch crucible and the filter disc. Check reading on balance for complete accuracy.)

B. INSTRUCTIONAL RESOURCES:

1. Available Media - a. Copies of EMP. b. OT-4, Overhead Transparencies -1, showing procedures listed on EMP, p. 16-5 used in lessons 1 and 2.

C. INSTRUCTIONAL APPROACH (Sequencing):

1. Presentation - Briefing (5 min.)

   a. Overhead - EMP p. 16-5, Procedures of test
   Tell students to use p. 16-5 as a "flow sheet" in laboratory.

   b. Assignment - Read from above: A. Instructional Objective, 1. Terminal Behavior.

   c. Assignment - Have students read Procedure H.

   d. Briefing - This is same weighing procedure they did in C. They will have to check for complete drying so when finished with Procedure H. put discs plus residue (on supports) into an oven (I.1.).

2. Student Performance and Evaluation (25 min.) As stated in Instructional Objective above, by Instructor rating.

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3. NOTE: Students stop after I.1. "Put disc plus residue (on support) into an oven." To avoid a time lag for drying and cooling, some other student activity should be planned for the next 35 minutes (minimum) of the 50 minutes required. Instructor/students should remove crucibles and discs from oven after 30 minutes and put them into desiccators for the 20 minute cooling period.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Check for Complete Drying (CH.SOL.SUS.EMP. Procedure I)

LESSON NUMBER: 4 of 6

ESTIMATED TIME: 45 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: This is part of the laboratory procedure to determine total suspended (non-filterable) solids, mg/liter.

ENTRY LEVEL BEHAVIOR: Learner must know how to weigh to 4 decimal places on an analytical balance and also be able to work subtraction problems involving decimals.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - Learner will re-weigh the discs plus residues and compare results with first weights. He will take appropriate action based on these results, all as presented as steps in EMP Procedure I as stated and/or described in the Information column.

2. Conditions - Learner will be given the equipment, the EMP, no assistance and 30 minutes.

3. Accepted Performance - Learner will correctly apply the criteria stated in I.15., judged by the Instructor when the data sheet is given to him.

B. INSTRUCTIONAL RESOURCES:

1. Available Media - a. Copies of EMP. b. OT-4, Overhead Transparencies - 2, showing procedures listed on EMP, p. 16-5 used in lessons 1, 2 and 3; and data sheet on EMP, p. 16-32.

C. INSTRUCTIONAL APPROACH (Sequencing):

1. Presentation - Briefing and Lecture (15 min.)

   a. Overhead - EMP p. 16-5. Procedures of test

   b. Assignment - Read from above: A. Instructional Objective, 1. Terminal Behavior.
   c. Assignment - Have students read Procedure I.

   d. Briefing - Steps 6 through 13 are the weighing procedure they did in C and H.

   e. Overhead - Use example on "Typical Laboratory Data Sheet" to illustrate Steps 14-16.

2. Student Performance and Evaluation (30 minutes) as stated in Instructional Objective above, by Instructor rating.

3. NOTE: If a student's weight difference does not meet the criteria in Step 15, he should repeat Procedure I. He can put the disc into the oven and return to class. He/someone else can remove the disc after 30 minutes to a desiccator and, after disc cools, he can weigh it during free time. Completed data sheets are due at beginning of the next class day.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Calculations and Reporting Data (CH.SOL.SUS.EMP, Procedures K and L)

LESSON NUMBER: 5 of 6

ESTIMATED TIME: 15 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner will be responsible for calculating results of the test and reporting this data.

ENTRY LEVEL BEHAVIOR: Learner must know how to multiply and divide factors in a fraction.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will select data from the test, calculate mg/liter suspended matter and report his results rounded to the nearest mg/liter as presented in EMP Procedures K and L.

2. Conditions - on the provided laboratory data sheet, given the EMP which presents an example of the stepwise calculation and the rules for rounding off results, with no assistance and unlimited time. (Homework)

3. Accepted Performance - Learner must turn in completed data sheet with the same answer (to the nearest mg/liter) as the Instructor calculates from the same data.

B. INSTRUCTIONAL RESOURCES:

1. Available Media - a. Copies of EMP. b. OT-4, Overhead Transparencies - 3, showing procedures listed on EMP, p. 16-5, calculation formula, and typical laboratory sheet on EMP, p. 16-32.

C. INSTRUCTIONAL APPROACH (Sequencing):

1. Presentation - Lecture (15 min.)
   a. Overhead - EMP p. 16-5 Procedures of Test
   This session will consider Procedures K and L.
   Overhead - Calculation Formula for overview.
   b. Lecture - Use EMP Procedures K and L, and the overhead of the Typical Laboratory Data Sheet to go through the stepwise examples of the calculation and rounding off procedures.

   c. Assignment - Using the data sheet and Procedure K, students are to calculate the mg/liter suspended solids in the influent and in the effluent samples tested. Then, as in Procedure L, they are to round off the answers to the nearest mg/liter. Two completed data sheets are due to the Instructor next morning. Student will receive one corrected copy later in the day.

2. Student Performance (Homework - about 10 minutes.) as stated in "Terminal Behavior" and "Conditions" above.

3. Student Evaluation: As stated in "Accepted Performance" above.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Total Suspended (Non-Filterable) Solids, mg/liter

UNIT OF INSTRUCTION: Follow-up and Summary of Subject Matter

LESSON NUMBER: 6 of 6

ESTIMATED TIME: 15 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Learner should have an opportunity to ask any questions about the procedure and also should receive some final comments on sample volumes and drying times.

ENTRY LEVEL BEHAVIOR: Learner will have performed entire procedure in CH.SOL. SUS.EMP.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - Learner will have any unresolved questions about the procedure answered and will particularly consider criteria for choosing sample volumes and drying times.

2. Conditions - EMP and corrected data sheet will be available.

3. Accepted Performance - by active participation in the 15 minute wrap-up session as judged by the Instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media - EMP, corrected data sheets.

C. INSTRUCTIONAL APPROACH (Sequencing):

1. Presentation: Lecture - Discussion (15 min.)
   a. Return corrected data sheets, retaining one set of copies for self.
   b. Discuss results if appropriate. Answer questions.
   c. Note EMP Training Guide VII, E.2b. (Criteria for choosing volumes of sample to be filtered). Answer questions.
   d. Note EMP Training Guide VII, G.3b. (Time required for complete drying). Answer questions.
   e. Answer any remaining questions.

2. Student Evaluation - Satisfactory participation in the session as judged by Instructor.

A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for

SETTLEABLE SOLIDS, ml/liter
(IMHOFF SETTLING CONE)

as applied in
WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

National Training and Operational Technology Center
Municipal Operations and Training Division
Office of Water Program Operations
U.S. Environmental Protection Agency

CH.SOL.set.IPW.1.5.77

Q. Settleable Solids, ml/liter (Imhoff Settling Cone)

1. The Federal Register (FR) issuance in Outline No. 1 of this Guide lists two methods for this determination: volumetric or gravimetric.

2. The volumetric method has been written in the Effluent Monitoring Procedure (EMP) format entitled, "Settleable Solids, ml/liter (Imhoff Settling Cone)".

3. The reference source for the EMP is 14th ed., APHA, "Standard Methods for the Examination of Water and Wastewater", p. 95. This is the only source for the procedure listed in the Federal Register.

4. The procedure in the EMP is for determining the volume of settleable solids in a WWTP sample.

5. In the following Instructional Package Worksheet, the lesson plan is for the student to perform this procedure.

6. Each student is to process one WWTP sample to determine settleable solids, ml/liter. The IPW equipment requirements are based on this assignment. If you choose a different assignment, adjust quantities accordingly.

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Settleable Solids, ml/liter (Imhoff Settling Cone)

UNIT OF INSTRUCTION: Summary of 5 Elements - CH.SOL.set.EMP

ESTIMATED TIME: 2 hours, 5 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner will be responsible for determining settleable solids using this method.

ENTRY LEVEL BEHAVIOR: None.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will assemble equipment, record sample identification information, determine settleable solids as ml/liter in an Imhoff Cone, record the result, and clean the cone and stirring rod using the steps and information given in CH.SOL.set.EMP.

2. Conditions - In a laboratory with minimal supervision, given classroom instruction, the EMP, a sample labeled with typical information, the required equipment, a laboratory data sheet (copy is in EMP), and 65 minutes working time.

3. Accepted Performance - Obtaining a result that agrees with ± 5 ml of the median of at least 3 results obtained by the Instructor on the same sample.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:

   a. EMP "Settleable Solids"; Standard Methods, 14th ed.; equipment supplies; 2 copies per student of data sheet in EMP, page 16.

   b. TC-42, Videocassette Tape Unit "Settleable Solids", 15 minutes, with 4 segments demonstrating:

      1) Preparation (overview, equipment and sample records)
      2) Determination (stepwise procedure)
      3) Results (reading and recording)
      4) Cleaning Equipment

C. INSTRUCTIONAL APPROACH (SEQUENCING):

1. Preparation for Instruction

   a. Duplicate two copies for each student of data sheet in EMP, page 16.

   b. Use list of equipment in D. (below) to supply laboratory stations for each student.

   c. Obtain plant sample for class with solids concentration sufficient to facilitate reading of settled matter by students.

   d. Label the samples, including information required on the data sheet.

C. INSTRUCTIONAL APPROACH (SEQUENCING) (Continued)

2. Distribute materials to each student - 5 minutes
   - a. Copy of EMP.
   - b. Two copies of data sheet (EMP, page 16)
3. Introduction: Lecture using EMP - 10 minutes
   - a. Objectives, page 4
   - b. Definitions, Training Guide I
   - c. Why test is performed, Training Guide I
   - d. Overview of test steps, Flow Sheet, page 5
4. Presentation of Lessons 1 and 2 - 25 minutes
5. Student Performance of:

   All of Lesson 1 - 10 minutes
   Lesson 2 (B steps 1, 2, 3, 4) - 15 minutes
6. Presentation of Lessons 3 and 4 - 20 minutes
7. Break
8. Student Performance of:

   Lesson 2 (B steps 6, 7, 8) - 20 minutes
   Lesson 3 - 5 minutes
   Lesson 4 - 5 minutes
9. Students turn in two completed data sheets (EMP, page 16) at the end of Lesson 4. Check all entries for accuracy. Make any corrections on both sheets -- one to be returned to the student and one to be retained for Instructor's evaluation of student and discussion in Lesson 5.
10. Presentation of Lesson 5 - 10 minutes
11. Evaluation is done by Instructor during student performance sessions according to the standards set down in the individual lessons.

D. IPW EQUIPMENT AND SUPPLY REQUIREMENTS:

(1 WWTP sample)

For each learner:

1. 1 Imhoff Settling Cone.
2. 1 stirring rod, the same length as cone.

Shared:

1. Imhoff Cone support, 3 place, 1 per 3 students.
2. Imhoff Cone brush or equivalent, 1 per 3 students.
3. Clock (the ideal would be for each student to have a 60 min. interval timer with alarm to signal the 45 minute settling time. Instructor should have at least 1 of these for one student to use as class demonstration.)

E. IPW REAGENT REQUIREMENTS: (minimum amounts per students)

1 liter WWTP sample.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Settleable Solids, ml/liter (Imhoff Settling Cone)

UNIT OF INSTRUCTION: A. Preparation for the Determination

LESSON NUMBER: 1 of 5

ESTIMATED TIME: 20 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: To determine settleable solids in a sample, the learner must have the required equipment ready to use and must record information about the sample on a laboratory record sheet.

ENTRY LEVEL BEHAVIOR: None

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior: The learner will recognize the required equipment, inspect it for cleanness and assemble it in a work area. He will also record sample identification, type, date and time collected, and name of sample collector.
2. Conditions - In a class or plant laboratory, given classroom instruction, the EMP, equipment, a sample labeled with necessary information, a data sheet, no assistance and 10 minutes.
3. Accepted Performance - The learner must accomplish the terminal behavior to the satisfaction of an Instructor's rating on assembling the equipment and with no blank spaces or errors in the sample record portion of the data sheet.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:
   a. Copies of the EMP; 2 copies per student of data sheet in EMP, page 16.
   b. TC-42, Videocassette Tape Unit "Settleable Solids", 5 minute segment giving an overview of the test, showing equipment to be used and telling the items of information about the sample to be recorded on the data sheet.

C. INSTRUCTIONAL APPROACH:

1. Presentation: (10 minutes)
   a. Assignment - Have students read Procedure "A. Preparation for the Determination".
   b. Introduce and run CCTV Cassette segment on "Preparation: Equipment - Sample Records".
   c. Question period on material presented.
   d. Assignment - Two completed data sheets are due to the Instructor at the end of the final laboratory session.
2. Student Performance and Evaluation: (10 minutes)

   As stated in Instruction Objective above.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Settleable Solids, ml/liter (Imhoff Settling Cone)

UNIT OF INSTRUCTION: B. Determination

LESSON NUMBER: 2 of 5

ESTIMATED TIME: 50 minutes*

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner will have this responsibility.

ENTRY LEVEL BEHAVIOR: Recognition and assembly of equipment to be used (lesson 1 of this series).

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior: The learner will determine Settleable Solids, ml/l in a sample according to Method 208F (p. 95) in Standard Methods, 14th ed. using the steps and information in CH.SOL.set.EMP

2. Conditions - In a laboratory, learner does the determination given a sample, the EMP and required equipment in 35* minutes with no assistance.

3. Accepted Performance - He must accomplish the terminal behavior to the satisfaction of an Instructor's rating. Also, his result must agree within ± 5 ml of the median of at least 3 results obtained by the Instructor on the same sample.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:
   - a. Copies of the EMP.
   - b. TC-42, Videocassette Tape Unit "Settleable Solids", 4 minute segment illustrating the determination in a stepwise manner.

C. INSTRUCTIONAL APPROACH:

1. Presentation: (15 minutes)
   - a. Assignment - Have students read Procedure "B. Determination."
   - b. Introduce and run CCTV Cassette segment on "Determination."
   - c. Question period on material presented.

2. Student Performance and Evaluation: (35 minutes*)

   As stated in Instruction Objective above.

* 3. NOTE: Time is based on utilizing the 45 minute settling period (B, Step 5) for presentation of lessons 3 and 4. Students then return to the laboratory and finish this lesson, and do lessons 3 and 4 as well.

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INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Settleable Solids, ml/liter (Imhoff Settling Cone)

UNIT OF INSTRUCTION: C. Results

LESSON NUMBER: 3 of 5

ESTIMATED TIME: 20 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Learner will be responsible for recording data.

ENTRY LEVEL BEHAVIOR: Learner will have performed a determination on a sample.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will record the result from lesson 2.
2. Conditions - Given the EMP with a laboratory data sheet and 5 minutes.
3. Accepted Performance - Learner must use correct units reporting his answer to the nearest whole ml per liter and also sign the data sheet.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:
    a. Copies of the EMP; copies of the data sheet.
    b. TC-42, Videocassette Tape Unit "Settleable Solids", 4 minute segment showing how to read results of samples with less than 40 ml/liter settleable solids and also of those with more than 40 ml/liter solids.

C. INSTRUCTIONAL APPROACH:

1. Presentation: (15 minutes)
    a. Assignment - Have students read Procedure "C. Results".
    b. Introduce and run CCTV Cassette segment on "Results".
    c. Question period on material presented.
2. Student Performance and Evaluation (5 minutes)

    As stated in Instructional Objective above

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INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Settleable Solids, ml/liter (Imhoff Settling Cone)

UNIT OF INSTRUCTION: D. Cleaning Equipment

LESSON NUMBER: 4 of 5

ESTIMATED TIME: 10 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: To facilitate future determinations, labware should be rinsed and cleaned as soon as possible after use.

ENTRY LEVEL BEHAVIOR: None

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - Learner will dispose of cone contents and rinse cone and stirring rod with tap water. He will then clean the cone and rod with soap, water and an Imhoff cone brush, rinse them with tap water, shake to dry and leave to drain on a sink.
2. Conditions - in a laboratory given the EMP, required equipment and 5 minutes.
3. Accepted Performance - Water should drain off of cone or rod without leaving many droplets.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:
   a. Copies of EMP.
   b. TC-42, Videocassette Tape Unit "Settleable Solids". 2 minute segment illustrating cleaning the rod and Imhoff Cone with water, then with water and soap.

C. INSTRUCTIONAL APPROACH:

1. Presentation: (5 minutes)
   a. Assignment - Have students read "D. Cleaning Equipment".
   b. Introduce and run CCTV Cassette segment on "Cleaning Equipment".
   c. Question period on material presented.
2. Student Performance and Evaluation: (5 minutes)
   As stated in Instructional Objective above.
3. Collect two completed data sheets from each student at the end of the laboratory session.

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INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Settleable Solids, ml/liter (Imhoff Settling Cone)

UNIT OF INSTRUCTION: Follow-up and Summary of Subject Matter

LESSON NUMBER: 5 of 5

ESTIMATED TIME: 10 minutes

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: The learner should receive his corrected data sheet and should have an opportunity to resolve any questions he may have about the subject matter.

ENTRY LEVEL BEHAVIOR: The learner will have performed the procedures in lessons 1 through 4 of this EMP.

A. INSTRUCTIONAL OBJECTIVE:

1. Terminal Behavior - The learner will receive a corrected data sheet from his performance of lessons 1 through 4 and will have any questions about the lessons answered.
2. Conditions - Corrected data sheet and EMP will be available for a 10 minute session.
3. Accepted Performance - Active participation in the wrap-up session as judged by the Instructor.

B. INSTRUCTIONAL RESOURCES:

1. Available Media:

   EMP, corrected data sheets.

C. INSTRUCTIONAL APPROACH:

1. Presentation: Lecture-Discussion (10 minutes)
   a. Return corrected data sheets, retaining one set of copies for self.
   b. Discuss results if appropriate.
   c. Answer any questions.
2. Student Evaluation - Satisfactory participation in the session as judged by the Instructor.

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A PROTOTYPE FOR DEVELOPMENT OF ROUTINE OPERATIONAL PROCEDURES

for the

REPORTING OF SELF-MONITORING DATA

as applied in

WASTEWATER TREATMENT FACILITIES
and in the
MONITORING OF EFFLUENT WASTEWATERS

INSTRUCTIONAL PACKAGE WORKSHEET

Developed by the

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. ENVIRONMENTAL PROTECTION AGENCY

WP.CH.IPW.(164.1)1a.9.77

GUIDELINES FOR
INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Reporting of Self-Monitoring Data

UNIT OF INSTRUCTION: Entry of Data on NPDES Discharge Monitoring Report

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 3/4 hour

JUSTIFICATION FOR THIS INSTRUCTIONAL OBJECTIVE: Reporting of Effluent Data at stipulated periods is a condition of a discharge permit.

ENTRY LEVEL BEHAVIOR: Student must be able to add, subtract, multiply, and divide using whole and decimal numbers.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Student will be able to report self-monitoring data in the proscribed manner.

2. Conditions - Classroom

3. Accepted Performance - Satisfactory completion of a Discharge Monitoring Report, given a sample set of data.

B. INSTRUCTIONAL RESOURCES

1. Available Media - EMPs "Geometric Mean" and "Flow Measurement." OT-14, Overhead Transparencies - various.

2. Suggested Media - Set of self-monitoring data for student use in completing Report Form.

C. INSTRUCTIONAL APPROACH (Sequencing)

Review format of Report Form and data to be entered.

Using typical self-monitoring results, go through the manner in which the data is to be handled and entered on the form.

Have students complete a blank form, using a set of data supplied for this purpose. Upon completion, review procedure with students.